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Epidemiology of Epidemic Keratoconjunctivitis

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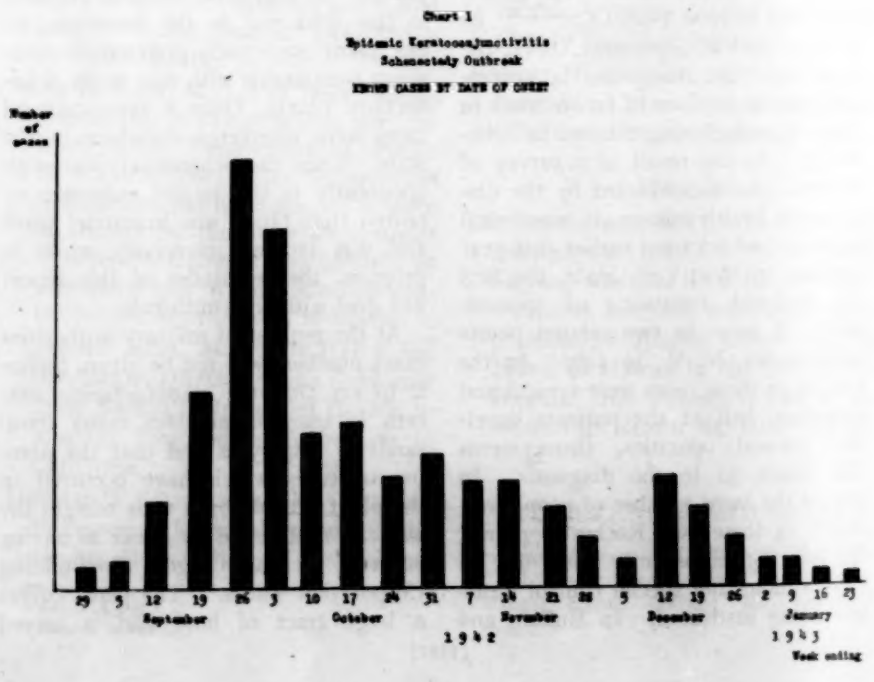
IN the summer and fall of 1941 outbreaks of epidemic keratoconjunctivitis were reported from Hawaii and from the West Coast.[1, 2, 3] In the early part of 1942 cases were first recognized in the East in New York City.[4, 5, 6] In the latter part of September, 1942, the disease was first recognized in upstate New York in the form of an outbreak in a large manufacturing concern in Schenectady. As the result of a survey of industrial plants conducted by the district state health officers, it was found that cases had occurred earlier that year elsewhere in New York State, the first such outbreak consisting of approximately 35 cases in two related plants in Rochester, N. Y., in July. As the histories in these cases were typical and more than half of the patients developed corneal opacities, there seems little doubt as to the diagnosis. In spite of the large number of people employed in these two Rochester plants, the infection apparently died out of itself without any special control measures being instituted. In Buffalo and vicinity a number of industrial plants had typical cases develop among their employees at about the same time that cases appeared in Schenectady, and although the aggregate number of cases in this area was in the hundreds, no one plant apparently suffered an incidence comparable with that in the Schenectady plant. Only a few scattered cases were uncovered elsewhere in the state. Since the Schenectady outbreak apparently is the largest epidemic reported thus far in one industrial plant and was studied intensively while in progress, the remainder of this report will deal with that outbreak.

At the request of military authorities exact numbers will not be given. Suffice it to say that the manufacturing concern in question employs many thousands of employees and that the number of cases which have occurred in the plant exceeds by a wide margin the 600 cases estimated by Rieke as having occurred in the Oregon Shipbuilding Corporation Yards.[3] The plant covers a large tract of land and is served

medically by a main dispensary located essentially in its center, together with a branch dispensary in charge of a physician at the east end of the plant. In addition there is a first aid room in the charge of a nurse at a subsidiary plant located elsewhere in the city.

THE DIAGNOSIS AND CLINICAL PICTURE

The cases were typical of those described in the literature [1, 2, 3] and the diagonisis was confirmed by Drs. Murray Sanders and Alson E. Braley, of the College of Physicians and Surgeons, Columbia University, New York. Furthermore, patients with the disease were demonstrated by Dr. Murray Sanders to have developed specific neutralizing antibodies against the virus previously isolated by him from New York City cases.[7] Although all gradations of severity were encountered, it was the general impression of visiting physicians who had seen cases elsewhere in the United States that on the average these cases were more severe than those they had encountered elsewhere. From September 28 to October 23, inclusive, essentially every case reporting to the plant's medical department was studied intensively (comprising several hundred definite cases and referred to from this point on as the "study sample"). Among this group of patients, 56.1 per cent developed the disease in both eyes and 85.5 per cent developed corneal opacities. In those with corneal involvement, the opacities appeared between the 7th and 20th day after onset in 92 per cent. The actual distribution of cases according to appearance of opacities by 7 day periods from date of onset was as follows: 0–6 days, 7.0 per cent; 7–13 days, 65.8 per cent; 14–20 days, 26.3 per cent; 21 days and over, 0.9 per cent. In only 19 per cent had the opacities disappeared by the end of the second month after onset.



CHRONOLOGICAL DEVELOPMENT OF OUTBREAK

As to the chronological development of the outbreak, a study of the number of visits to the eye clinic revealed a definite rise beginning September 10. The distribution of known cases by date of onset is shown in Chart 1. Since the investigation of the outbreak was not begun until September 24, a few cases probably occurred prior to that date which were not seen and are not indicated on the chart. Furthermore, in some cases the date of onset was not determined. However, it is believed the number of such cases was not sufficiently great to affect materially the characteristics of the chart.

It will be noted from Chart 1, that some patients dated the onset of their infection in the last week of August. Cases increased precipitously to a peak in the week ending September 26. The outbreak declined less rapidly than it developed, but ultimately approached the zero line by the week ending January 23, 1943. Only a few scattered cases have occurred since that time. One might ask whether the introduction of new employees (presumably non-immune) into the plant population may not have served to keep the outbreak going. The facts, however, do not support this theory, since study of all the cases with onsets from December 1 through March 13 fails to show any who had been employed at the plant less than 6 months.

The manner of introduction of the infection into the plant could not be ascertained. During the previous spring a number of cases of conjunctivitis had occurred among the employees, but corneal opacities did not develop in these cases nor were the other diagnostic characteristics present. The plant's ophthalmologist stated definitely that clinically the cases which occurred that spring were not the same disease which appeared in the fall. Furthermore, no neutralizing antibodies were found in serum from one of these patients, 5 months after onset. The number of such cases was so small that the total number of visits to the eye clinic during those months was not appreciably affected. This is in contrast with the marked increase in total visits in the fall because of the appearance of epidemic keratoconjunctivitis.

An intriguing lead was encountered when it was learned that a fairly large corps of employees had been sent to the Hawaiian Islands in March, 1942, to help repair the damage at Pearl Harbor. However, it was found that all but two of the group returned to Schenectady after October 21, 1942; that is, some time after the peak of the epidemic keratoconjunctivitis outbreak had been passed. None of the group had developed epidemic keratoconjunctivitis nor, in fact, were they aware of any cases in Hawaii. The two men who returned prior to October 21 arrived in August and the first week of September, respectively. Although the possibility that the employee returning in August was a passive carrier cannot be definitely refuted, it seems rather absurd to attempt to attribute the outbreak to this man, in view of the presence of the disease earlier that year in New York City and elsewhere in the state, the hiring of many new employees from various parts of the United States, and the transferring of employees back and forth between the Schenectady plant and plants of the concern located elsewhere in the country.

GEOGRAPHICAL DISTRIBUTION OF CASES

The geographical distribution of the cases did not assist in determining the manner of introduction of the infection and direction of spread. A spot map of known cases made on the first day of investigation (September 24) revealed that cases had already been reported from essentially every building

in the plant; and an analysis later by date of onset showed almost simultaneous appearance of the disease in many buildings. Certain buildings, however, suffered attack rates somewhat higher than others. There appeared to be no particular geographical concentration of the buildings with the lower attack rates except that essentially all of the buildings at the east end of the plant had proportionately fewer cases. These buildings are mostly office buildings and are served by the branch dispensary.

TABLE 1

Epidemic Keratoconjunctivitis

Schenectady Outbreak

Attack Rate for Each Sex by Type of Building

	Attack Rate Per cent		
Type of Building	*Male*	*Female*	*Both Sexes*
Entire plant	1.3	0.5	1.1
Selected buildings:			
Heavy manufacturing	2.7	...	2.6
Light manufacturing	1.1	1.1	1.1
Light assembly	0.6	0.4	0.5
Exclusively clerical	0.3	0.2	0.3

In Table 1 buildings have been combined according to whether they represent heavy manufacturing, light manufacturing, light assembly work, or exclusively clerical work, and attack rates have been calculated on the basis of the study sample defined above. It will be noted that employees in the buildings representing heavy manufacturing (manufacture of massive steel structures involving welding, gas cutting, planing, etc.) suffered the highest attack rate, with progressively lower attack rates occurring among those engaged in light manufacturing, light assembly work, and exclusively clerical work.

This table also is of interest from the standpoint of the sex distribution of cases. The great majority of cases occurred among males, but the great majority of the plant population consists of males. However, even on an attack rate basis, it was noted that for the entire plant the males suffered an attack rate over twice that for females. When these sex specific attack rates are broken down according to buildings grouped by type of work, the sex difference essentially disappears and the difference with regard to the entire plant is due chiefly to the fact that few women are employed in the buildings involving heavy manufacturing processes.

OCCUPATION, AND POSSIBLE ROLE OF FOREIGN BODY IN THE EYE

This brings up the question as to the rôle of foreign bodies in the eye as a predisposing factor in the development of the clinical illness. Determining the existence of such a relationship and distinguishing it from the possible rôle the eye dispensary might have played in dissemination of the infection are very difficult problems. The first symptom of the disease may simulate that of a foreign body and at first the patient may think that he merely has something in his eye. If such a person goes to the eye dispensary because of this sensation and then shortly afterward develops the rest of the symptoms of the disease, he may get the erroneous impression that he acquired his infection at the eye clinic. Even in the case of actual removal of a foreign body from the eye in the dispensary several days before development of the disease, the subsequent appearance of epidemic keratoconjunctivitis might have been due to a predisposing rôle played by the trauma of the foreign body rather than infection of the eye acquired in the clinic during the process of removing the foreign body.

Determining attack rates by occupation is of some assistance in attacking this problem. Using the study sample to calculate attack rates by occupation, the figures indicated in Table 2 are ob-

TABLE 2

Epidemic Keratoconjunctivitis

Schenectady Outbreak

Incidence according to Type of Work

Type of Work	Attack Rate Per cent		Type of Work	Attack Rate Per cent	
	Total	No. Visit *		Total	No. Visit *
Physicians, nurses	31.3	25.0	Stockroom keepers	1.7	1.1
Welders, cutters	6.5	3.5	Truck drivers	1.7	1.2
Solderers, babbiters	6.3	2.7	Supervisors	1.5	0.9
Crane followers	5.5	3.0	Receivers, shippers	1.2	1.2
Chippers, filers, grinders	3.9	2.8	Assemblers	1.2	0.6
Sheet metal workers	3.4	2.0	Laborers, porters	1.1	0.4
Painters, varnishers	3.3	3.3	Winders	1.0	0.6
Policemen	3.1	2.2	Platers, dippers, polishers	0.7	0.7
Maintenance and repair workers	2.9	1.6	Miscellaneous	0.7	0.3
Machine and press operators	2.0	1.2	Engineers	0.6	0.5
Testers	1.9	0.7	Clerks	0.4	0.3
Tool and die makers	1.8	1.1	Draftsmen	0.1	...

* i.e., exclusive of those having visited the eye clinic 3–14 days prior to onset of the epidemic keratoconjunctivitis

tained. A striking feature of this table is the high attack rate among dispensary physicians and nurses, indicating the communicable nature of the infection under conditions of intense exposure. Upon studying the attack rates among the other occupations, it would appear that higher attack rates were sustained by employees in occupations more apt to result in eye trauma. However, since this might merely mean more frequent visits to the eye dispensary where infection might be acquired, a parallel row of rates has been calculated in which all cases have been omitted in which there was a history of a visit to the eye dispensary from 3 to 14 days prior to onset. Essentially the same relationships are maintained in this second series of rates. Offhand, this would seem to indicate a relationship to occupation, per se, but as will be discussed later there may be another explanation.

Not indicated in this table is the fact that workers on the night (second and third) shifts had attack rates almost twice as high as those on the day shift. This is explainable by the fact that the night shifts include a relatively greater proportion of workers in occupations with higher attack rates. Possibly the presence of the infection in a male nurse handling some of the eye cases at night had a bearing on this problem. This individual continued to work during his illness. The total number of cases in persons on the night shifts was not large enough to influence appreciably the occupational distribution of the total group of cases.

Also not indicated in Table 2 was the high attack rate (5 among 11 men, or 45.4 per cent) in volunteer night firemen, whose daytime jobs were various and widely scattered, but who at night congregated at the firehouse and slept in a dormitory. It happens that these sleeping quarters are on the second floor of the main dispensary, but it is not believed that this indicates any causal relationship. It is felt that the high attack rate among these firemen was probably due to their prolonged and intimate contact with each other following the introduction of a case into their midst. No case occurred among the 8 professional firemen on day duty only.

To assist further in the solution of this problem, histories were secured from a series of several hundred em-

TABLE 3

Epidemic Keratoconjunctivitis

Schenectady Outbreak

*Comparison of Some Possibly Predisposing Factors among Cases Compared with Sample Population **

Possibly Predisposing Factors	Per cent among E.K. Cases: Total	Per cent among E.K. Cases: No. Visit †	Per cent among General Population *
Work necessitates looking at bright light	19.7	16.9	20.1
Work involves close work with eyestrain	24.1	21.2	43.4
Work often results in foreign bodies in eye	38.9	35.6	16.5
Work involves wearing goggles	40.6	40.2	19.2
Visited Main Dispensary eye clinic within 14 days of onset in cases, or within past 14 days in sample population			
— for foreign body in eye	34.4	....	5.3
— for other eye complaints	13.9	....	3.5

* Histories from employees coming to dispensaries because of common cold

† Indicates no visit to eye clinic at the Main Dispensary within 3–14 days prior to onset

ployees reporting consecutively to the dispensaries because of the common cold. This was for the purpose of securing data for the plant population as a whole to be used for comparison with the data secured on the history sheets for the epidemic keratoconjunctivitis cases. This method of sampling the employee population was decided upon when plant officials deemed it impractical to obtain the data by interviewing every one-hundredth person on the pay roll. The sex distribution of these common cold cases (21 per cent females) agreed well with the sex distribution of the plant population as a whole (23 per cent females), and the distribution by buildings also agreed well with the distribution of the employee population as a whole. The investigation of the study group of epidemic keratoconjunctivitis cases preceded in time the survey of workers with the common colds. However, the average daily number of visits to the dispensary for foreign bodies in the eye was essentially the same in each period (219 and 250, respectively). It seems reasonable, therefore, to assume that the data with regard to the cold survey group can be considered representative of the general plant employee population for purposes of comparison with the epidemic keratoconjunctivitis study group. Some of these comparisons are given in Table 3.

First, let it be noted from this table that in over half of the cases (51.7 per cent) the patients gave no history of having visited the eye clinic within 14 days prior to onset. It is obvious, therefore, that the eye dispensary was not the principal direct means of dissemination of the infection. A similar observation was made by Rieke in the Oregon cases.[3] However, that such dissemination can occur has been demonstrated by Sanders[6] in his investigation of 80 cases of the disease in New York City in which transmission apparently occurred through an ophthalmologist's office.

From Table 3 it seems clear that work which involved looking at a bright light, or close work with eyestrain, did not predispose to the development of epidemic keratoconjunctivitis, since the per cent of the general employee population engaging in such work was essentially the same or greater than among employees developing epidemic keratoconjunctivitis. The higher per cent among the general employee population giving a history of close

work involving eyestrain is explainable by the greater proportion of clerks and stenographers in this group. When it comes to work likely to result in foreign bodies in the eye and work involving the wearing of goggles, one notes a definitely higher percentage with a history of such work among those who developed the disease, compared with the average employee. When one considers the question of a previous visit to the main dispensary eye clinic, the discrepancy between the two groups is even more pronounced. Even when visits to the eye clinic for conditions other than a foreign body are considered, there is a significant discrepancy.

FOREIGN BODY VERSUS DISSEMINATION BY EYE DISPENSARY

An association between the acquiring of foreign bodies in the eye and the development of epidemic keratoconjunctivitis is indicated from Chart 2. In this chart the epidemic keratoconjunctivitis attack rates have been arranged in order according to various buildings, and on the same chart has been plotted the per cent of the workers in each of these buildings who visited the main dispensary eye clinic in July because of a foreign body in the eye (prior to the appearance of epidemic keratoconjunctivitis in the plant). The general correlation is obvious. (In this calculation only buildings with employee populations exceeding 2 per cent of the total employees have been considered, since rates based on smaller numbers would be capricious.)

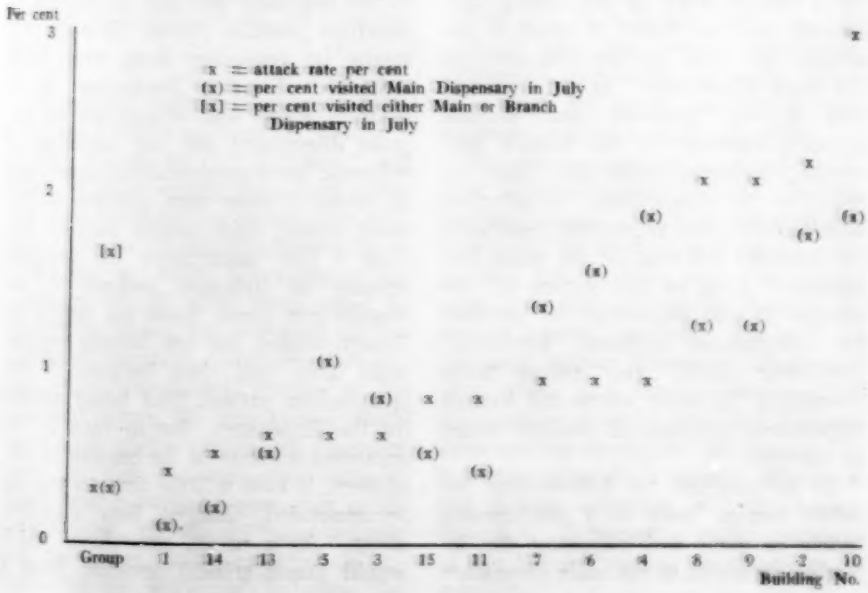
It should be noted that as stated this diagram represents visits to

CHART 2

Epidemic Keratoconjunctivitis

Schenectady Outbreak

Apparent Correlation between Epidemic Keratoconjunctivitis Attack Rate and Visit to Main Dispensary because of Foreign Body in Eye



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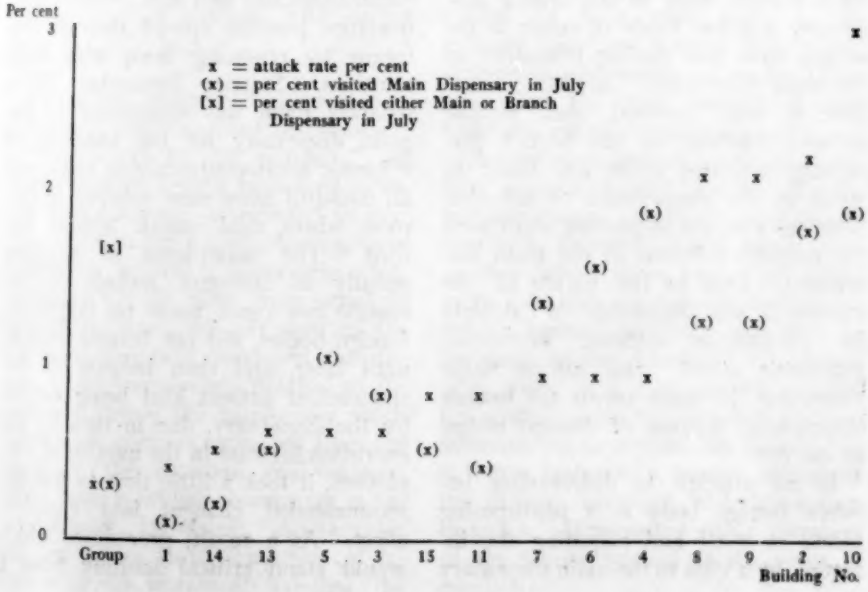

the eye clinic in the *main* dispensary. The building marked "group" on the diagram is a combination of the buildings in the east end of the plant, where the branch dispensary is located, and represents about one-fifth of the total plant population. If the visits in July to the branch dispensary for foreign bodies in the eye are added to the visits to the main dispensary, 1.7 per cent of the employees in this group of buildings visited a dispensary in July for this reason, as indicated by the cross in brackets, which now obviously throws this group out of line. Although the figures upon which these percentages are based cannot be recorded here, it should be said that this alteration in the per cent of visits for foreign bodies in the eye made by the "group" is highly significant statistically. This finding has at least two possible explanations: first, that the types of foreign bodies acquired by the workers (largely clerical) in this group of buildings did not predispose to the development of the disease to the same extent as foreign bodies acquired elsewhere in the plant; or second, that treatment for a foreign body in the branch dispensary was less likely to result in infection than was similar treatment at the main dispensary. In this connection it was observed that routine technics followed by the branch dispensary appeared much less likely to result in the transmission of infection from one eye case to another, than were the technics followed in the main dispensary. Due to the nature of the records it was impossible to calculate for comparison epidemic keratoconjunctivitis attack rates among those consulting the main versus the branch dispensaries because of foreign bodies in the eye.

In an attempt to differentiate between foreign body as a predisposing factor in itself and acquiring the infection by a visit to the main dispensary eye clinic, the per cent of epidemic keratoconjunctivitis cases giving a history of having visited the eye clinic within 3 to 14 days prior to onset were calculated according to the week of onset. The thought in so doing was that if the eye clinic was serving as a means of dissemination, the per cent of cases giving a history of having visited the eye clinic within 3 to 14 days prior to onset would increase as the epidemic got under way. The cases for the weeks ending August 29 and September 5 were too small in number to permit reliable percentages. For the weeks ending September 12, 19, 26, and October 3, the per cents giving a history of having visited the eye clinic 3 to 14 days prior to onset were, respectively, 7.2 per cent, 32.8 per cent, 36.3 per cent, and 47.0 per cent.

CONTROL MEASUBES AND IMPLICATION AS TO MODE OF SPREAD

Before the intensive investigation of the epidemic was initiated, the plant authorities, suspecting that the eye solutions used in the dispensary might have been at fault, had studied them bacteriologically and had attempted to interrupt possible spread through this means by replacing them with fresh solutions. Starting September 28, a separate room was established in the main dispensary for the handling of epidemic keratoconjunctivitis cases, and all doubtful cases were referred to this room where rigid aseptic technic was used. The importance of applying equally as stringent technic to the routine eye cases, made up largely of foreign bodies, did not become evident until later, and then because of the tremendous patient load being carried by the dispensary, due in turn to the enormous increase in the number of employees, it took a little time to put the recommended changes into complete effect. As a result, procedures which would stand critical scrutiny from a

bacteriological standpoint were not actually instituted for every eye case visiting the dispensary until December 17. These procedures consisted principally of thorough washing of hands routinely between patients, using a separate sterilized dropper for each patient, and frequent sterilization of instruments and solutions.

In view of this date (December 17) it is of interest that although in the 4 calendar weeks from November 29 to December 26, inclusive, 47.9 per cent of the cases gave a history of having visited the eye clinic 3 to 14 days prior to onset, during the next week (December 27 to January 2) this per cent dropped to 33.3 per cent, and from then until the end of the period of observation (March 13) none of the cases gave such a history. As a matter of fact, in each of the few cases occurring subsequent to December 17 in which there was a history of prior visit to the eye clinic, that visit had been made before December 17. Thus there was no evidence that after December 17 the eye clinic could possibly have been responsible for dissemination of the infection, in contrast with earlier data.

SECONDARY CASES IN HOUSEHOLDS

A study was also made of members of the households of patients. All alleged attacks among household members were confirmed or rejected by personal visits to the home. Among those households in which observation was continued for 28 days from onset in the original case, 4.9 per cent of the household members developed the disease. This corresponds roughly to the incidence among the employees, which was 4.1 per cent, as estimated from the study of the common cold sample. Rieke made a similar observation in the Oregon cases. He states: "Also notable was the rather spotty extension of infection to the workmen's families, the percentage incidence roughly paralleling that among the men." [3] In the secondary household cases in the Schenectady outbreak, the great majority of the household secondary cases occurred among adult females, as one might expect, in view of the fact that the great majority of cases in the plant occurred among adult males. Even on an attack rate basis adult females in the households experienced the highest rate; among household members over 15 years of age, females experienced an attack rate of 7.2 per cent compared with 1.1 per cent attack rate among males. As to children in the families, 3.9 per cent of the girls and 3.3 per cent of the boys developed the disease. It was observed that in general the illnesses were milder in the children.

Secondary cases among household members were most likely to have their onsets during the 2nd and 3rd week after onset in the primary case. The attack rates in the 1st, 2nd, 3rd, and 4th weeks after onset in the primary case were 0.17 per cent, 1.2 per cent, 1.4 per cent, and 0.8 per cent, respectively. In one instance a case occurred 32 days after onset in the primary case, the longest interval encountered, and which, of course, might have been the result instead of some unknown extrahousehold exposure.

Several cases among household members were of special interest. In one instance spread continued through one family to another related family. In another family there were 3 secondary cases. In still another the flow of infection seemed reversed; the wife of the plant worker developed the disease after going to a local ophthalmologist for a dacryo-cystitis, and her husband subsequently developed the disease. In a fourth instance, a woman developed the disease, although with no known exposure. However, 4 other members of the family worked at the plant in question.

CASES ELSEWHERE IN THE CITY

As to incidence in the community, no cases appear to have been observed in residents of the city prior to the appearance of cases in the plant. Another large manufacturing plant in the city, employing about one-fourth the number of workers in the first concern, experienced a wave of epidemic keratoconjunctivitis among its employees which, however, was distinctly secondary, chronologically, to the first outbreak. In an attempt to avoid the experience of the first plant, this concern instituted a policy of supposedly rigid exclusion from work of all employees developing the disease until 2 weeks after onset. Despite this policy, their employees suffered an attack rate roughly comparable with that in the first concern.

DISCUSSION

The situation in the last of the households discussed above suggests the existence of carriers, since the woman who developed a typical attack of the disease was not employed in the plant and had no other known exposure to a case, and yet there were 4 members of the household who were workers in the plant. Although none of these workers had any symptoms suggestive of the disease, it seemed possible that they might have brought the infection home. Accordingly, blood specimens from the case and 3 of the family members were collected 6 months after onset in the case and submitted to Dr. Murray Sanders for study. The findings are of considerable interest, since sera from each of the 4 persons showed 1,000 neutralizing doses to the virus isolated by Dr. Sanders. The widespread distribution of cases in the plant as early as September 24, taken in conjunction with the small percentage of the employees suffering clinical attacks of the disease, further suggest that the virus may be readily transmitted from person to person (respiratory?), but that only a small percentage of those becoming infected develop a clinical attack. Serological studies of atypical cases and household contacts and plant employees who failed to acquire the clinical illness are being made and may throw some light on this problem.

If this conception that clinical cases represent just a fraction of the total number of infected individuals is correct, the question then arises as to what factors predispose to development of the clinical infection. The three usual factors may be considered, namely, variation in virulence of the virus, variation in dosage, and variation in resistance of the host. There is no evidence as to variation in the virulence of the virus. There was a clinical impression that cases became more mild as the outbreak progressed, which would be contrary to the usual experience with repeated passage of a virus. However, it seems more likely that this impression was a false one due to the fact that the outbreak had been under way several weeks before investigation was started, so that among the cases with onset in August or early September, only the more severe cases were still showing acute symptoms when the investigation commenced. There may also have been the factor of a greater tendency later in the outbreak for the milder cases to report to the clinic, in response to publicity and instructions.

As to dosage, the high attack rate among physicians and nurses employed in the dispensary and the high attack rate among adult females in the households of patients would seem to indicate that more intense exposure is more likely to result in development of the clinical disease. In none of the cases developing among household members was there a history of a foreign body during the 2 weeks prior to their onset. This was also true, with one exception, among the physicians and nurses who acquired the disease. The experience

among the volunteer night firemen further indicates the important rôle of intimate contact in spread of the infection.

As to factors influencing resistance in the host, the variation in rate according to occupation, with cases omitted which might possibly have been instances of infection acquired at the eye clinic, suggests offhand that some factor related to occupation might have altered resistance to the virus. One is immediately impressed with the higher attack rates in those occupations in which the eye is more likely to be traumatized, and it would seem reasonable that trauma to the eye might result in reducing resistance to invasion of the virus. That there was a relationship between the likelihood of acquiring ocular foreign bodies and the development of the disease was demonstrated by the correlation by buildings between frequency of reporting to the eye clinic for foreign bodies in July, prior to the outbreak, and the epidemic keratoconjunctivitis attack rates. Also of interest in this connection is the higher percentage of the epidemic keratoconjunctivitis cases giving a history of engaging in work involving the likelihood of developing foreign bodies in the eye, wearing goggles, and of prior visits to the eye clinic, in contrast with the sample of the employee population. At least part of this difference, however, could be due to dissemination of the infection through the eye clinic, and other evidence would seem to indicate that such dissemination in the eye clinic did play a rôle in the spread of the infection among employees. There is the possibility, moreover, that the difference in rates by occupation is merely a reflection of dissemination through the eye clinic, since such transmission would result in an earlier and heavier seeding in the occupational groups reporting more frequently to the eye clinic and thus, in turn, result in greater spread to fellow workers through contact.

Referring to the cases observed in the industrial plants in Rochester and Buffalo, the routine technics practised in the Rochester plants were very good from an aseptic standpoint, and may have contributed to the infection's dying out so promptly in those plants. As to Buffalo, in a disproportionately large number of the cases scattered among various plants, there was a history of a prior visit to a certain few ophthalmologists' offices, suggesting dissemination of infection through these offices.

SUMMARY

Epidemic keratoconjunctivitis appeared in New York State in 1942, first in New York City and later in scattered areas in upstate New York.

An unusually extensive outbreak, apparently the largest to be reported thus far in a single plant, occurred in a manufacturing concern in Schenectady.

Following a rapid rise in the number of cases in September, the outbreak declined, leveling off to a fairly high incidence which was maintained until particularly rigid aseptic technics were instituted in the eye clinic; subsequently new cases decreased to negligible proportions. Approximately 4 per cent of the employee population was affected with a definite attack of the disease, and approximately the same proportion of household members of patients developed the infection after onset in the primary case.

An occupational selection was demonstrated which seemed correlated with the likelihood of eye trauma, but which may have been a reflection of the rôle played by the eye dispensary in dissemination of the infection.

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REFERENCES

1. Holmes, W. J. Epidemic Infectious Conjunctivitis. *Hawaii M. J.*, 1:1–72 (Sept.), 1941.

2. Hogan, M. J., and Crawford, J. W. Epidemic Keratoconjunctivitis. *Am. J. Ophth.*, 25:1059 (Sept.), 1942.

3. Rieke, F. E. Epidemic Conjunctivitis of Presumed Virus Causation: Report of an Estimated Six Hundred Cases in One Shipyard. *J.A.M.A.*, 119: 942 (July 18), 1942.

4. Sanders, M. Epidemic Keratoconjunctivitis ("Shipyard Conjunctivitis"). *Arch. Ophth.*, 28:581 (Oct.), 1942.

5. Sanders, M., and Alexander, R. C. Epidemic Keratoconjunctivitis. I. Isolation and Identification of a Filtrable Virus. *J. Exper. Med.*, 77:71 (Jan. 1), 1943.

6. Sanders, M., Gulliver, F. D., Forchheimer, L. L., and Alexander, R. C. Epidemic Keratoconjunctivitis. Clinical and Experimental Study of an Outbreak in New York City. Further Observations on the Specific Relationship Between a Virus and the Disease. *J.A.M.A.*, 121:250 (Jan. 23), 1943.

7. Unpublished data. Also see reference 4.

A Practical Study of Lauryl Sulfate Tryptose Broth for Detection of the Presence of Coliform Organisms in Water*

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THE studies, initiated by the Committee on Standard Methods in 1934, of media proposed for detection of the presence of coliform organisms in water, the results of which have been reported at various times (1935,[1, 2] 1937,[3] and 1939 [4]), were continued during the past two years by conducting a practical test of another medium, lauryl sulfate tryptose broth, proposed by W. L. Mallmann and C. W. Darby.[5, 7]

The Medium

The composition of the medium tested was the following:

	Grams
Bacto-tryptose	20
Bacto-lactose	5
Potassium phosphate dibasic	2.75
Potassium phosphate monobasic	2.75
Sodium chloride	5
Sodium Lauryl Sulfate (Duponol WA Flakes)	0.1

The ingredients were dissolved in 1 liter of cold distilled water, distributed into tubes and autoclaved at 15 lbs. pressure for 15 minutes. The final pH was approximately 6.8.

In this medium, tryptose was employed, instead of peptone, because of its better productivity and selectivity; and sodium lauryl sulfate was included because of its selective effect, somewhat similar to that of some other surface tension depressants such as oxgall, in inhibiting the multiplication of certain non-coliform organisms.

Cowles [6] first proposed the use of sodium lauryl sulfate for this purpose. Mallmann and Darby [7] employed it in their preliminary work in the form of Duponol W. A. Paste,* a commercial product used as a detergent and wetting agent in the textile and other industries. A similar product, Duponol W. A. Flakes,† containing a somewhat larger proportion of sodium lauryl sulfate, was employed in the present study because of its apparently greater stability.

Outline of the Work

The medium described was distributed, in dehydrated form, through the courtesy of Difco Laboratories, Detroit, Mich., to the following 17 state, provincial, county, city and university laboratories in the United States

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* Because of the excessive demands to which all laboratories were subjected following the outbreak of war, the labor involved in conducting this study and in compiling and reporting the results thereof, was divided between Dr. W. L. Mallmann, Chairman of the Standard Methods Committee on Water and Sewage, and the writer. It was arranged that the former should initiate the study, enlist laboratories to collaborate in the study and collect the results secured by them, whereupon these results were to be compiled and reported by the latter in his capacity of Referee for the committee. Accordingly, the original results from the collaborating laboratories were transmitted to the Referee early in the year, and from them was prepared the present report.

† Duponol products are manufactured by E. I. Du Pont de Nemours and Company, Wilmington, Dela.

and Canada, the directors of which agreed to collaborate in the study:

Laboratories	*Collaborators*
Connecticut State	Friend Lee Mickle
Maryland State	C. A. Perry and A. A. Hajna
Minnesota State	H. A. Whittaker and D. M. Taylor
Quebec Provincial	Jacques Archambault
West Virginia State	Katherine E. Cox
Louisiana—Caddo Shreveport Health Unit	Alvin F. Meyer
Indiana—Indianapolis Water Co.	C. K. Calvert and E. R. Hupp
Michigan—Detroit Filtration Plant	W. M. Wallace; Fabien, and Rausch
Highland Park " "	Irving Dahljelm
Escanaba " "	S. J. Shank
Flint " "	C. H. Burdick and W. V. Kennedy
Saginaw " "	J. C. Richardson and A. C. Pendell, Jr.
Wyandotte " "	Harry W. Ward
Missouri—St. Louis Public Health	Jane I. Burns
California—Stanford University	Paul Beard
Pennsylvania—Pennsylvania State College	Michael A. Farrell
University of Pennsylvania	David Lackman

The laboratory procedures specified for the comparative work included, briefly, planting of several portions (usually five 10 ml. and one 1.0 ml. portions) of sample in both lactose broth and lauryl sulfate tryptose broth; upon appearance of gas in these primary media, eosin-methylene-blue agar plates were streaked and colonies appearing on the plates were fished to both lactose broth and lauryl sulfate tryptose broth, and also to agar slants for microscopic examination. An additional transfer from gas positive tubes of one or both primary media to brilliant green bile (2 per cent) was also made by the majority of the collaborating laboratories, and the formation of gas in the bile, after incubation at 37° C. for 48 hours, was recorded.

It will be noticed that the procedures specified included two departures from the usual Standard Methods procedure: the substitution of lauryl sulfate tryptose broth for lactose broth as a primary medium, and also its substitution as a secondary medium in the "completed test."

Aggregate Results

Since some of the collaborating laboratories made no transfers of primary gas positive tubes to brilliant green bile, and some made such transfers only from lactose broth, the results will be reported under these headings: (A) with no transfer from primary gas positives; (B) with transfer from lactose broth primary gas positives; (C) with transfer from both lactose broth and lauryl sulfate tryptose broth gas positives. Consequently (B) will include (C), omitting from the latter the results of transfer to brilliant green bile from lauryl sulfate tryptose primary gas positives; and, likewise, (A) will include both (B) and (C), omitting from both of the latter the results of transfer to brilliant green bile.

Table 1 shows the aggregate results, reported by the various collaborating laboratories, from samples that yielded one or more primary gas positives. A large number of other samples were examined but, as they gave no gas positives when planted in the two primary media, are not included in the tabulations.

Table 1-A—A total of 17 laboratories reported the results shown in Table 1-A. It will be observed that, from 605 water samples yielding one or more primary gas positives, 1,873 of 3,415 portions of sample, or 54.8 per

TABLE 1

Primary Medium	No. of Sample Portions Planted	Portions Gas Positive		Gas Positives Completely Confirmed Using Secondary				Gas Positive upon Transfer of Primary to Brilliant Green Bile	
				Lactose Broth		L.S.T. Broth			
		No.	Per cent of Sample Portions	No.	Per cent of Sample Portions	No.	Per cent of Sample Portions	No.	Per cent of Sample Portions
A. Aggregate Results of Examination of 605 Water Samples Yielding Primary Gas Positives With No Transfer of Primary Positives to Brilliant Green Bile									
Lactose broth	3,415	1,873	54.8	1,117	32.7	1,142(1)	33.4		
L.S.T. broth	3,415	1,628	47.7	1,222(3)	35.8	1,261	36.9		
B. Aggregate Results from 526 Water Samples Yielding Primary Gas Positives With Transfer of Lactose Broth Primary Positives to Brilliant Green Bile									
Lactose broth	2,996	1,687	56.3	1,025	34.2	1,052(1)	35.1	1,088(2)	36.3
L.S.T. broth	2,996	1,486	49.6	1,115(3)	37.2	1,150	38.4		
C. Aggregate Results from 318 Water Samples Yielding Primary Gas Positives With Transfer of Lactose Broth and Lauryl Sulfate Tryptose Broth Primary Positives to Brilliant Green Bile									
Lactose broth	1,732	1,016	58.7	540	31.2	527(1)	30.4	579(2)	33.4
L.S.T. broth	1,732	775	44.7	586(3)	33.8	575	33.2	601(1)	34.7

Note: The figures in parentheses (which are included in the adjoining totals) represent the number of missing tubes, incomplete results, etc., which were considered positive in order to avoid loss of the remaining data obtained from these particular samples; a study of these data suggests that the error thus introduced is very probably negligible.

cent, planted in lactose broth, gave gas positives; whereas, 1,628 of a like number of sample portions, or 47.7 per cent, planted in L.S.T. (lauryl sulfate tryptose) broth yielded gas positives. When these primary positives were plated on eosin-methylene-blue agar and colonies fished to lactose broth and to L.S.T. broth, and to agar slant for microscopical examination, the 1,873 lactose broth primary positives yielded 1,117 complete confirmations of coliform organisms using secondary lactose broth, and 1,142 complete confirmations using lauryl sulfate tryptose broth. Consequently, the substitution of L.S.T. broth for lactose broth as a secondary medium yielded 25, or slightly over 2 per cent, more complete confirmations.

The use of lauryl sulfate tryptose broth as a primary medium reduced the number of primary gas positives from 1,873 to 1,628, or slightly over 13 per cent, but yielded 1,222 complete confirmations when using lactose broth as a secondary medium, and 1,261 when using L.S.T. broth as a secondary medium.

The number of complete confirmations of coliform organisms (1,117) obtained by the use of the usual procedure, employing L.B. (lactose broth), compares with the numbers secured by the use of L.S.T. broth at various stages of the procedure as follows:

Primary		*Secondary*	*No.*	*Per cent*
L.B.	—	L.B.	1,117	100.0
L.B.	—	L.S.T.	1,142	102.2
L.S.T.	—	L.B.	1,222	109.4
L.S.T.	—	L.S.T.	1,261	112.9

Thus the use of L.S.T. broth, as primary and as secondary in the completed test, permitted an increase of 12.9 per cent in the number of complete confirmations compared with the usual procedure using lactose broth in these positions, despite a reduction of 13.1 per cent in the number of primary gas positives that had to be examined when using L.S.T. broth.

It is evident that this series of results indicates an increase in the number of sample portions containing coliforms detected through the use of L.S.T. broth, both as a primary and as

a secondary medium, which, although not very great, is nevertheless significant.

Lauryl sulfate tryptose broth was suggested as a primary medium principally because it gave promise of serving as a presumptive medium in which the formation of gas might be considered a practically sure indication of the presence of coliform organisms. In this respect, however, only 77.5 per cent of the L.S.T. primary gas positives yielded coliforms, even when using L.S.T. broth as a secondary medium, compared with 61.0 per cent of complete confirmations secured from lactose broth primary gas positives using the same secondary medium, and 59.6 per cent using lactose broth as the secondary medium. These relationships are shown below in tabular form:

Primary	*Secondary*	*Primary Gas Positives*	*Complete Confirmations*	
			No.	*Per cent*
L.B.	—L.B.	1,873	1,117	59.6
L.B.	—L.S.T.	1,873	1,142	61.0
L.S.T.	—L.B.	1,628	1,222	75.1
L.S.T.	—L.S.T.	1,628	1,261	77.5

It is interesting to compare these figures with those obtained in a previous study,[3] reported in 1937, of the utility of fuchsin broth as a primary medium, with lactose broth the secondary medium, when a number of laboratories collaborated in the examination of 890 waters from various sources. Of 2,903 primary gas positives in fuchsin broth, 70.5 per cent were completely confirmed, whereas of 4,204 lactose broth primary positives, 50.2 per cent were completely confirmed. The number of complete confirmations from fuchsin broth primary gas positives was 97.06 per cent of that from lactose broth primary gas positives, whereas the present study indicates the number of complete confirmations, using L.S.T. broth as primary and secondary media, was 112.9 per cent of that from lactose primary gas positives. Obviously, to judge from these figures, L.S.T. broth is the better medium of the two; but, as in the use of fuchsin broth, primary gas positives in L.S.T. broth must also be confirmed.

It has been suggested[5] that the plating medium, eosin-methylene-blue agar employed in the Standard Methods procedure for the "completed test," inhibits the growth of some coliform organisms; and that, for this reason, gas in primary fermentation tubes constitutes evidence of the presence of coliform organisms more frequently than successful complete confirmation indicates. This contention is indeed probable, but the magnitude of the error thus introduced is problematical. A previous study[2] showed, by transfer from primary gas positives to various liquid media followed by complete confirmation of gas positives in the latter, that the error of the usual completed test performed on primary lactose broth positives averaged, at least, about 14 per cent, even when employing eosin-methylene-blue agar in the complete confirmation of the liquid confirmatory gas positives. If a practicable plating medium less inhibitive than E.M.B. agar can be found for use in the "completed test," the present procedure of complete confirmation may have to be debited with an additional error; but until the magnitude of the error due to the use of E.M.B. agar is definitively determined, there appears to be no alternative to acceptance of this plating medium in the "completed test."

Finally, the aggregate results shown in Table 1-A indicate that L.S.T. broth could not be employed as a presumptive test of the samples examined without confirmation, but that its use both as primary and secondary medium in the "completed test" permitted about 13 per cent more complete confirmations than did the use of lactose broth, with a reduction of about 13 per cent in the

number of primary gas positives that had to be confirmed.

Table 1-B—Fifteen laboratories included a transfer from primary lactose broth gas positives to brilliant green bile in their examination of 526 water samples. It will be observed that the relationships between the "completed test" results, shown in Table 1-B, secured from the use of lactose broth and lauryl sulfate tryptose broth in the examination of these samples, resemble fairly closely those described in the discussion of the results of Table 1-A.

Use of the "confirmatory test," employing transfer to brilliant green bile from lactose broth primary gas positives and considering formation of gas in the bile to constitute evidence of the presence of coliform organisms, indicated 36.3 per cent of the sample portions planted to contain these organisms. This proportion is slightly higher than the 34.2 per cent of complete confirmations secured by the usual Standard Methods procedure, and the 35.1 per cent by the same procedure using L.S.T. broth instead of lactose broth as the secondary medium. It is slightly lower, however, than the proportion of 37.2 per cent obtained from the use of L.S.T. broth as the primary medium, and that of 38.4 per cent secured by employing L.S.T. broth both as primary and secondary media.

Table 1-C—Eleven laboratories included transfers from both lactose broth and L.S.T. broth primary gas positives to brilliant green bile in their examination of 318 water samples.

The results of this series, given in Table 1-C, show that the proportions of water sample portions in which the presence of coliform organisms was indicated by these two "confirmatory" procedures compared with the complete confirmation procedures as shown above, right.

Evidently the indications of the presence of coliform organisms furnished by gas formation in brilliant green bile, following transfer from either lactose broth or L.S.T. broth primary gas positives, were slightly less numerous (33.4 per cent) and slightly more numerous (34.7 per cent), respectively, than those (33.8 per cent) furnished by the complete confirmation of L.S.T. primary positives using lactose broth secondary, which in this series of examinations yielded the best of the "completed test" results.

P.i-mary	*Second-dary*	*Gas in B.G.B.*	*Per cent of Water Sample Portions Positive*
L.B.	—L.B.		31.2
L.B.	—L.S.T.		30.4
L.S.T.	—L.B.		33.8
L.S.T.	—L.S.T.		33.2
L.B.		+	33.4
L.S.T.		+	34.7

It may be concluded, therefore, from the aggregate results of Table 1, that L.S.T. broth could not be employed in a presumptive test, without confirmation, of these waters; that the substitution of L.S.T. broth both as primary and secondary media yielded somewhat more frequent complete confirmation of the presence of coliform organisms than the other complete confirmation procedures, and about the same number of indications of the presence of coliforms as that from the use of lactose broth primary followed by the brilliant green bile confirmatory test (gas only); and that the use of L.S.T. primary followed by the brilliant green bile confirmatory test furnished, by a small margin, the greatest number of indications of the presence of coliforms.

RESULTS FROM DIFFERENT TYPES OF WATERS

The data summarized in Table 1 are distributed in Table 2 according to type of water examined. Under each type heading are given three sets of figures corresponding to the A, B, and C

groups of Table 1, the first set showing the results secured when no transfer of primary gas positive to brilliant green bile was made, the second set when such transfer was made from lactose broth primary gas positives, the third set when such transfer was made from both primary media gas positives. The first set of figures includes the second and third, and the second set includes the third, as in Table 1.

It will be observed in Table 2 that the results secured from the various types of waters present as a rule the same general picture as that furnished by the aggregate results. The L.S.T.

TABLE 2

Results of Examination of Different Types of Waters

Raw	*Primary Medium*	*No. of Sample Portions Planted*	*Portions Gas Positive Per cent*	*Complete Confirmations Using Secondary*		*Gas in B.G. Bile upon Transfer from Primary Per cent*
				L.B. Per cent	*L.S.T. Per cent*	
12 laboratories	L.B.	750	66.9	46.5	45.7	....
139 samples	L.S.T.	750	64.1	48.8	48.8	....
12 laboratories	L.B.	695	67.2	46.8	45.8	46.8
128 samples	L.S.T.	695	64.0	48.1	48.1	....
9 laboratories	L.B.	515	71.3	47.2	45.6	48.4
98 samples	L.S.T.	515	65.2	48.2	46.8	47.6
Unfinished						
10 laboratories	L.B.	535	50.7	15.3	15.3	....
99 samples	L.S.T.	535	21.1	15.9	16.3	....
10 laboratories	L.B.	517	50.1	15.5	15.5	17.4
95 samples	L.S.T.	517	21.7	16.2	16.6	....
8 laboratories	L.B.	481	53.4	16.6	16.6	18.7
92 samples	L.S.T.	481	21.8	17.5	17.7	18.9
Finished						
9 laboratories	L.B.	434	37.6	10.8	11.1	....
77 samples	L.S.T.	434	16.1	11.8	11.5	....
8 laboratories	L.B.	410	39.3	11.5	11.7	12.0
73 samples	L.S.T.	410	16.3	11.7	11.5	....
6 laboratories	L.B.	332	41.3	10.2	10.8	11.1
60 samples	L.S.T.	332	16.9	12.3	11.4	13.9
Pools						
5 laboratories	L.B.	310	35.8	17.7	16.8	....
58 samples	L.S.T.	310	24.5	19.4	20.0	....
3 laboratories	L.B.	90	38.9	31.9	31.9	30.0
15 samples	L.S.T.	90	37.8	34.4	34.4	....
3 laboratories	L.B.	78	43.6	34.6	34.6	33.3
13 samples	L.S.T.	78	41.0	38.5	38.5	38.5
Wells Springs						
7 laboratories	L.B.	1,195	61.0	44.5	45.8	....
200 samples	L.S.T.	1,195	66.0	50.7	52.3	....
6 laboratories	L.B.	1,099	60.9	44.9	46.2	48.0
184 samples	L.S.T.	1,099	66.3	51.3	52.9	....
3 laboratories	L.B.	308	69.1	48.7	46.8	55.8
52 samples	L.S.T.	308	76.6	56.8	56.2	58.8
Miscellaneous (type not reported)						
6 laboratories	L.B.	191	50.8	27.2	36.6	....
32 samples	L.S.T.	191	51.8	28.3	37.2	....
5 laboratories	L.B.	185	51.9	28.1	37.8	37.8
31 samples	L.S.T.	185	53.5	29.2	38.4	....
2 laboratories	L.B.	18	44.4	33.3	27.8	27.8
3 samples	L.S.T.	18	55.6	44.4	44.4	44.4
Sea Water						
1 laboratory	L.B.	40	45.0	40.0	42.5	45.0
10 samples	L.S.T.	40	55.0	50.0	50.0	....

broth primary gas positives were usually less numerous than the lactose broth gas positives, 56 to 58 per cent less numerous in the case of unfinished and finished waters, although slightly more numerous in the case of well and spring, miscellaneous, and sea waters.

The proportion of L.S.T. primary gas positives that were shown by the "completed test" (using L.S.T. broth as secondary medium) to contain coliform organisms, varied from about 70 per cent for finished waters to 82 per cent for swimming pool waters, the percentage usually ranging between 75 and 80. Evidently the formation of gas in primary L.S.T. broth could not be considered very sure proof of the presence of coliform organisms.

As a rule there was very little difference between the results of employing lactose broth and L.S.T. broth as secondary media in the "completed test."

The use of L.S.T. broth as both primary and secondary media in the "completed test," however, permitted isolations of coliforms from more sample portions than did the use of lactose broth, as indicated below:

Type of Water	*Per cent of Positive Completed Tests Using Usual Standard Method (Lactose Broth)*
Raw	105
Unfinished	106
Finished	106
Swimming pools	113
Wells and springs	117
Sea water	125
Miscellaneous	137

These figures do not indicate much advantage, as regards positive complete confirmation, in substitution of L.S.T. broth for lactose broth in the examination of waters from purification plants, but it must be remembered that fewer primary positives had to be confirmed when L.S.T. broth was employed. In the examination of swimming pools, wells and springs, and other waters, however, this substitution increased the number of positive complete confirmations by 13 to 37 per cent.

The "confirmatory tests," employing transfer from primary gas positives to brilliant green bile, indicated as a rule about the same frequency of presence of coliform organisms as did the best of the "completed tests," with one exception: four (Minnesota, Pennsylvania State College, Quebec, West Virginia) of the six laboratories performing "confirmatory tests" of well and spring waters reported a total of positive "completed tests," using L.S.T. broth primary and secondary, which was about 16 per cent greater than that of "confirmatory tests" with brilliant green bile following lactose broth primary. An interesting feature of the reports from these four laboratories on ground waters was the greater number of primary gas positives in L.S.T. broth (554) compared with that in lactose broth (509). Generally, however, the greatest number of positive indications of the presence of coliforms was secured by the use of L.S.T. broth primary followed by "confirmatory" brilliant green bile, taking formation of gas in the latter to constitute a positive result.

Consequently, the results from the various types of water samples examined confirm in general the conclusions derived from the aggregate results. Furthermore, the separate groups of results reported by the various collaborating laboratories, with few exceptions, also confirm these conclusions.

FINISHED WATERS

Since the use of L.S.T. broth appears to reduce the number of primary gas positives that must be confirmed, particular interest attends its employment in the examination of finished waters, which usually yield an excessive proportion of false lactose broth primary gas positives. Consequently Table 3

TABLE 3

Results of Examination of Finished Waters

Laboratory	*Primary Medium*	*Sample Portions Planted*	*Primary Gas Positives*	*Complete Confirmations Using Secondary*		*Gas in B.G. Bile upon Transfer from Primary*
				L.B.	*L.S.T.*	
Indianapolis, Ind.	L.B.	97	56	0	0	0
	L.S.T.	97	0	0	0	0
Maryland	L.B.	42	16	6	6	6
	L.S.T.	42	13	13	11	13
Penn. State Coll.	L.B.	24	12	3	4	5
	L.S.T.	24	10	6	5	8
Penn. University	L.B.	103	41	25	26	26
	L.S.T.	103	32	22	22	25
Saginaw	L.B.	30	6	0	0	0
	L.S.T.	30	0	0	0	0
Wyandotte, Mich.	L.B.	36	6	0	0	0
	L.S.T.	36	1	0	0	0
Minnesota	L.B.	42	12	8	8	8
	L.S.T.	42	8	5	7	..
Quebec	L.B.	30	11	5	4	4
	L.S.T.	30	2	1	1	..
Louisiana	L.B.	12	1	0	0	..
	L.S.T.	12	3	3	3	..

is presented, showing the results reported by those laboratories that examined at least a few finished water samples.

Of the six laboratories, listed in Table 3, that reported coliforms in finished waters, three isolated more by the use of the usual Standard Method procedure using lactose broth than by the use of L.S.T. broth primary, whereas the experience of the other three laboratories was the reverse.

These data are too few in number to permit a conclusion regarding the applicability of lauryl sulfate tryptose broth to the examination of finished waters. Much more information is needed to establish whether the medium inhibits coliform organisms that have been subjected to purification processes.

CONCLUSIONS

Seventeen laboratories situated in the United States and Canada have collaborated in a study of the utility of lauryl sulfate tryptose broth for detection of the presence of coliform organisms in water. A total of 605 water samples from which primary gas positives were obtained, was examined, employing L.S.T. broth as a primary and as a secondary medium for comparison with lactose broth in the Standard Methods "completed test" procedure. Of these samples, 526 were also subjected to the "confirmed test" procedure employing transfer from lactose broth primary gas positives to brilliant green bile; and 318 were examined further by transfer from L.S.T. broth primary gas positives to brilliant green bile.

The results reported by the collaborating laboratories indicated that, in general:

1. A reduction of about 13 per cent in the number of sample portions producing gas in the primary medium resulted when L.S.T. broth was substituted for lactose broth, this reduction being particularly evident in the results from unfinished, finished and swimming pool waters.

2. As coliform organisms were isolated from only 75.1 per cent of L.S.T. broth primary gas positives when using lactose broth secondary, and from 77.5 per cent when using L.S.T. broth secondary in the usual Standard Methods "completed test" procedure, it is evident that L.S.T. broth could not be employed as a presumptive medium, without confirmation, in the examination of these waters.

3. Since the use of L.S.T. broth as both primary and secondary media permitted iso-

lation of coliform organisms from 1,261 sample portions, about 13 per cent more than the 1,171 portions from which isolations were secured when lactose broth was employed, the substitution of the former medium for the latter appeared to be advantageous; but the paucity of data reported on finished waters precludes a definitive conclusion at this time regarding the utility of L.S.T. broth in the examination of this important group of waters.

4. The use of the "confirmed test" (transfer of primary gas positive to brilliant green bile, taking gas in the latter to indicate the presence of coliform organisms) yielded about as many positive results as did any of the "completed tests," whether transfer was made from the lactose broth or the L.S.T. broth primary gas positives. Transfer from the L.S.T. broth, however, resulted in a small increase (3.8 per cent) in the number of positive "confirmed tests" compared with transfer from lactose broth gas positives.

On the whole, the substitution of lauryl sulfate tryptose broth for lactose broth in the Standard Methods procedures promises a reduction in the number of primary gas positives to be confirmed and an increase in the number of positive indications of the presence of coliform organisms. Consequently further study of the medium by interested laboratories is recommended, particularly with reference to its utility in the examination of finished waters.

REFERENCES

1. Ruchhoft, C. C., and Norton, John F. Study of Selective Media for Coli-aerogenes Isolation. *J. Am. W. W. Assoc.*, 27, 9:1134 (Sept.), 1935.

2. Ruchhoft, C. C. Comparative Studies of Media for the Determination of the Coli-aerogenes Group in Water Analysis. *J. Am. W. W. Assoc.*, 27, 12:1732 (Dec.), 1935.

3. McCrady, M. H. A Practical Study of Procedures for the Detection of the Presence of Coliform Organisms in Water. *A.J.P.H.*, 27, 1243 (Dec.), 1937.

4. McCrady, M. H. A Comparison of MacConkey's Broth and Standard Lactose Broth as Media for Detection of Coliform Organisms in Water. *A.J.P.H.*, 29, 1250 (Nov.), 1939.

5. Darby, C. W., and Mallmann, W. L. Studies on Media for Coliform Organisms. *J. Am. W. W. Assoc.*, 31, 689 (Apr.), 1939.

6. Cowles, P. B. A Modified Lactose Broth for Use in the Presumptive Test. *J. Am. W. W. Assoc.*, 30, 979 (June), 1938.

7. Mallmann, W. L., and Darby, C. W. Uses of a Lauryl Sulfate Tryptose Broth for the Detection of Coliform Organisms. *A.J.P.H.*, 31, 127 (Feb.), 1941.

Poliomyelitis in Cuyahoga County, Ohio, 1941*

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WITHIN recent years Cuyahoga County has experienced frequent outbreaks of anterior poliomyelitis. During the period 1925–1940, the median number of resident cases reported annually was 40, and no year was free from the disease. In the lowest year, 1938, only 5 cases were reported and in the highest, 1930, the total reached 170. If incidence higher than the median be taken as the criterion, there have been 8 epidemics within this period.

In 1941 the county suffered its largest epidemic, with 189 reported cases. Of these, 134 were residents of Cleveland and 55 of the remainder of the county which includes 13 smaller cities, 40 villages, and 6 townships. The annual attack rate per 100,000 population was 15.5 for the entire county, 15.3 for Cleveland, and 16.2 for the rest of the county. Provisional figures indicate that incidence for the county was approximately twice as high as that for Ohio (7.0) and for the whole United States (6.8). The local character of the epidemic is evident from the fact that the number of cases reported in Ohio was slightly lower in 1941 than in 1940. In 1940 the disease was most prevalent in the North Central and Northwestern States; in 1941, in the East South Central and South Atlantic States.[1]

The present study is an analysis of records collected at the time of this epidemic and on reëxamination of survivors from 4 to 6 months after attack.

I. DATA COLLECTED DURING EPIDEMIC

A central county register for poliomyelitis was established in July, 1941, and current epidemiological records were obtained by public health nurses. Fortunately, 179, or 95 per cent, of the cases were hospitalized. Of these, 174 were admitted to the Contagious Division of the Cleveland City Hospital and 5 to other hospitals in the area. It was thus possible to verify the diagnosis, check the accuracy of many of the entries on the nurses' schedules, and supplement the health department records.

CLINICAL FINDINGS

Type of disease—The clinical classification of all cases reported during the year is presented in Table 1. A striking feature of poliomyelitis is that the relative frequency of various clinical types may differ considerably from epidemic to epidemic. The high propor-

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tion of bulbospinal and bulbar cases (31.2 per cent) indicates the severity of the epidemic. Only 17.5 per cent were abortive. This is in sharp contrast to the epidemics of 1931 and 1937 in Cuyahoga County, in which 50 per cent and 40 per cent, respectively, of the cases were abortive.[2]

TABLE 1

Clinical Classification of Cases of Poliomyelitis, Cuyahoga County, 1941

Type	*Number*	*Per cent*
Paralytic (total)	156	82.5
Spinal	97	51.3
Bulbospinal	30	15.9
Bulbar	29	15.3
Abortive	33	17.5
All types	189	100.0

Early signs and symptoms—Fever was the most frequent prodromal symptom, occurring in 70 per cent of both paralytic and abortive cases. Muscle pain, headache, stiff neck or back, vomiting, nausea, and fatigue were the next most frequent in order of occurrence.

The interval elapsing between onset of the disease and appearance of paralysis or muscular weakness was ascertained for 133 of 156 cases. Paralysis appeared most frequently on the third day. By the end of the first week paralysis was noted in 80 per cent of those in whom it was ultimately detected. Probably some of the longer intervals are attributable to error in date of onset or to failure to detect muscular weakness promptly.

Spinal fluid—Results of spinal fluid examinations were available for 174 of the cases. Only 5 individuals (3 per cent) had counts of less than 10 cells per cu. mm. and 12 (7 per cent) had counts of 300 or over. The median cell count was 83. There was little difference between cell counts of paralytic and abortive cases.

Differential spinal fluid cell counts were available for 171 cases. Only 10 cases (6 per cent) had counts in which more than 50 per cent of cells were polymorphonuclear. In 109 (64 per cent) the mononuclear leukocytes predominated and in 52 (30 per cent) only mononuclear cells were present. Here again there was little difference as between the various types of the disease.

EPIDEMIOLOGY

Chronology—Prior to July, 4 cases had been reported, 2 in January and 2 in April. During the first week of July, 1 case occurred in the city of East Cleveland and another in the village of University Heights about three miles away. No connection was established between these cases. Thereafter the increase was rapid and the epidemic reached its peak during the first week of August.

Characteristically, the rise of the epidemic curve was steeper than its fall. One-quarter of the cases had onset prior to August 3, one-half prior to August 17, and three quarters prior to September 6. That is, the second quarter of the epidemic required only 14 days for development, from August 3 to August 17, while the third quarter required 20 days, from August 17 to September 6. All but 2 cases had their onset before October 16.

Geographical distribution—Cases occurred in practically all parts of the county but the distribution was not uniform. In the northeastern section, where the epidemic ran an earlier course, the attack rate was 24.6 per 100,000 as compared to 12.6 for the remainder of the county. At the outset some factor peculiar to the section, such as contaminated milk supply or other food, was suspected. No evidence of this was obtained as is discussed later.

Age—Acute anterior poliomyelitis is commonly referred to as infantile paralysis. Recent trends in age distribution of individuals attacked, however, together with frequent occurrence of the abortive or non-paralytic type of the

disease, have made the term misleading. Smaller proportions of cases appear to be occurring in the very young. Thus in the New York City epidemic of 1916, 79 per cent of cases were under 5 years of age while in that of 1935 in the same city only 34 per cent of reported cases were in children of this age group.

In Cuyahoga County a similar change has taken place. This is shown in Table 2 where the age distributions of cases in 5 outbreaks of poliomyelitis, in which more than 50 cases were reported, are presented. The contrast between the ages of cases in 1941 and in 1930 is especially striking. The percentage of cases under 5 years of age in 1941 was slightly more than one-third that observed in 1930, but the percentage of cases 15 years and over was almost 6 times greater. As a result the median age of cases in 1941 (10.1 years) was 5 years higher than in 1930.

TABLE 2

Percentage Age Distribution of Cases of Poliomyelitis in Epidemics of 1930, 1933, 1934, 1937, and 1941, Cuyahoga County

Age (Years)	Year				
	1930 (170 Cases)	1933 (63 Cases)	1934 (51 Cases)	1937 (70 Cases)	1941 (189 cases)
Under 5	31.2	28.6	31.4	41.4	19.0
5–9	34.1	41.3	33.3	22.9	30.2
10–14	10.6	27.0	17.6	27.1	27.5
15–19	1.2	3.1	9.8	5.7	12.7
20 and over	2.9	....	7.9	2.9	10.6
Total	100.0	100.0	100.0	100.0	100.0
Median (years)	4.9	7.6	7.8	6.9	10.1

Despite these changes in age selectivity of the disease, poliomyelitis still attacks individuals under 15 years of age far out of proportion to their representation in the population. *Seventy-seven per cent* of all cases reported in 1941 were in persons of these ages who constitute only *20 per cent* of the population of the county.

Sex—A finding common to most outbreaks of poliomyelitis is that males are attacked more frequently than females. The usual percentages are about 55 per cent and 45 per cent, respectively.[3] In this epidemic the excess was somewhat higher, 115, or 61 per cent of the cases, occurring in males. The attack rate for males was 18.8 per 100,000 and for females, 12.2.

Study of the percentage distribution of clinical types of disease by sex revealed no significant difference. This is in direct contrast to the findings of Davis, Weber, and Arey [4] in an epidemic of 196 cases in Charleston County, S. C., in 1940, in which the spinal type of the disease was found to be significantly more frequent in females than in males, while the reverse was true for the bulbar and bulbospinal types.

Males were attacked at somewhat earlier ages, their median age being 9.2 years as compared to 11.5 years for females.

Race—In the present epidemic 9 of the individuals reported were Negroes. The attack rate for the Negro population was 11.6 per 100,000 and that for the white 15.8. Of cases among Negroes, 5 were abortive, 2 spinal, 1 bulbospinal, and 1 bulbar.

Multiple cases—The 189 cases of poliomyelitis occurred in 180 different families. There were 2 families with 3 confirmed cases each, and 5 with 2. Nine of these cases were of the spinal type, 3 bulbar, 1 bulbospinal, and 3 abortive. Not all of the 9 subsequent cases can be classified as secondary since, in the 2 households with 3 cases each, 2 cases occurred on the same day, and in 2 other

households the interval was only one day. Since the incubation period of the disease is usually considered to fall within the limits of 5 to 20 days after exposure it is more probable that in these families the cases were simultaneously infected than that one infected the other. In the remaining households the later case may have contracted the disease from the earlier, since the intervals between onsets were, respectively, 5, 10, 11, 12, and 15 days. Of these secondary cases 3 were spinal in type, 1 was bulbar, and 1 abortive.

The household schedules were incomplete as regards number and ages of household associates of the 184 primary cases. The estimated number of associates is 438. Among these there occurred 5 cases at the intervals given above, an attack rate of 1.1 per cent, far in excess of that for the entire year for the general population (15.5 per 100,000 or 0.015 per cent).

In addition to these 5 secondary cases only 1 had a history of probable contact. Two cases occurred in the same apartment house within 14 days of each other. Thus, in common with other urban epidemics of poliomyelitis, this outbreak was characterized in general by a lack of obvious association between frank cases of the disease.

Water supply—Only 3 cases occurred outside the area of the Cleveland distribution system. There is no direct evidence, therefore, either for or against the transmission of the virus by drinking water in this epidemic.

Milk supplies—The source of milk used within 3 weeks prior to onset was given for 145 cases. Of these 1 had used canned milk only. For another, the source was the family cow. The remaining individuals obtained milk from 39 of the 135 authorized dairies of the county. There was not a disproportionately large number of cases among the customers of any of these.

Uncooked fruits and vegetables—Facts regarding the consumption of uncooked fruits and vegetables were available for 172 cases. Of these only 5 had not used raw fruits and vegetables within 3 weeks prior to onset of disease. The names of the stores at which these articles were purchased were not obtained and it is impossible to tell whether there was a disproportionate number of cases among the customers of any grocer. Because of the wide geographic distribution of the cases this appears unlikely.

Thus, from the foregoing, together with other characteristics of the epidemic, it appears unlikely that the virus was spread by the agency of any fruit, vegetable, milk, or water supply.

Swimming—A precautionary measure taken by health officials during the epidemic was the closing of several swimming pools and beaches within the county. A history of swimming within 3 weeks before onset of symptoms was given by 48 individuals and a history of no swimming by 107. On 34 records no information was given. The proportion of swimmers, for persons of the ages attacked, does not seem to have special significance but the swimming status of the general population is unknown.

Attack rates by economic areas of the county—Information as to economic status of inhabitants of various census tracts of Cuyahoga County was obtained in 1940 by the Real Property Inventory and was made available by Howard Whipple Green. For statistical purposes the county has been divided into economic tenths according to the average rentals of rented houses and equivalent rentals of owned homes in census tracts. Each of these tenths includes approximately 29,000 families, one-tenth of the total families of the county. It was possible, therefore, to distribute the cases of poliomyelitis by economic tenths and to compute the corresponding attack rates.

These rates are presented in Table 3.

With the exception of Economic Tenth 5, which had the highest attack rate, the inhabitants of Economic Tenths 7, 8, 9, and 10 experienced rates consistently higher than the remainder of the county. That is, individuals living in areas of more expensive rentals were attacked by the disease somewhat more frequently than those living in other areas.

TABLE 3

Attack Rates per 100,000 Population by Economic Tenths; Poliomyelitis, Cuyahoga County, 1941

Economic Tenth	Average Rentals of Rented Homes and Equivalent Rentals of Owned Homes in Census Tract	Cases	Population	Attack Rate
1	$7.15–$19.42	14	110,258	12.7
2	19.51– 22.75	9	113,452	7.9
3	22.90– 25.48	16	120,925	13.2
4	25.52– 28.34	14	121,449	11.5
5	28.47– 31.78	37	128,564	28.8
6	31.80– 33.52	13	119,437	10.9
7	33.60– 35.42	22	118,538	18.6
8	35.49– 41.59	23	136,147	16.9
9	42.91– 53.04	21	122,800	17.1
10	54.20–170.54	20	125,680	15.9
	Total	189	1,217,250	15.5

This fact is emphasized since the discovery of the virus of poliomyelitis in excreta and in sewage points to the possibility of infection by the gastrointestinal route. Also the isolation of the virus from flies in Cleveland and elsewhere [5] during the summer of 1941 gave widespread popularity to the idea that the present epidemic was spread by these insects. It would seem that if excreta are a major factor either directly or through the agency of flies, inhabitants of lower economic areas would have experienced higher attack rates. It should be added that no directly pertinent epidemiological data were collected regarding the possible incrimination of flies as a vector of the virus. All the facts which have been collected, including the rather gradual development of the epidemic, the earlier peak in the northeastern section of the county, and the failure to incriminate any water, milk, or food supply, are consistent with the opinion that the disease was spread chiefly by human carriers and that the effective vehicle was discharges from the upper respiratory tract.

Case fatality—There were 16 deaths recorded among the 189 cases, a fatality rate of 8.5 per cent. This was lower than the average case fatality for poliomyelitis in Cuyahoga County during the periods 1925–1930 (11.5) and 1931–1935 (14.2), but slightly higher than that for the period 1936–1940 (6.6).

The fatality rate varied markedly according to sex and age (Table 4). The rate for males (11.3) was nearly 3 times that for females (4.1). The risk of death was greatest for males of 10 years

TABLE 4

Case Fatality Rates (Per cent) by Age and Sex; Poliomyelitis, Cuyahoga County, 1941

Age (Years)	Males			Females			Total		
	Cases	Deaths	Rate	Cases	Deaths	Rate	Cases	Deaths	Rate
Under 10	64	4	6.3	29	2	6.9	93	6	6.5
10–19	39	6	15.4	37	1	2.7	76	7	9.2
20 and over	12	3	25.0	8	..	...	20	3	15.0
Tota	115	13	11.3	74	3	4.1	189	16	8.5

TABLE 5

Case Fatality Rates (Per cent) by Sex and Clinical Type of Disease; Poliomyelitis, Cuyahoga County, 1941

Type	Males			Females			Total		
	Cases	Deaths	Rate	Cases	Deaths	Rate	Cases	Deaths	Rate
Spinal	58	..	....	39	..	....	97	..	....
Bulbospinal	21	6	28.6	9	1	11.1	30	7	23.3
Bulbar	17	7	41.2	12	2	16.7	29	9	31.0
Abortive	19	..	....	14	..	....	33	..	....
Total	115	13	11.3	74	3	4.1	189	16	8.5

of age and over and least for females of the same ages.

Deaths occurred among the bulbospinal and bulbar cases only (Table 5). For the bulbar type approximately 1 of every 3 attacked died and for the bulbospinal 1 of every 4. Although the fatality rate for each type was higher for males than for females, the number of cases was too small to make the difference significant.

The fatality rate for cases with onset before the median date was higher than for those of the second half of the epidemic. This is attributable entirely to a marked change in fatality rate in the bulbar type. Of the 13 bulbar cases with onset before the median date 7 died while of the 16 with onset after that date only 2 died.

II. REËXAMINATION OF SURVIVORS, FEBRUARY–MARCH, 1942

In February, 1942, approximately 6 months after the peak of the epidemic, arrangements were made for muscle examinations of the survivors. The purpose was to assess the type and extent of disabilities and to inform the attending physician of the findings. Each of the survivors who reported at the clinic was given a uniform examination to determine the degree of residual paralysis in the muscles of the legs, arms, abdomen, back, neck, face, speech, and deglutition. The results were recorded on standard muscle examination charts.

From the completed charts it was possible to classify the survivors into one or another of the following groups:

Group I—Individuals in whom no weakness or paralysis in any group of muscles was discovered.

Group II—Individuals whose gait was normal and who appeared to have unimpaired use of all extremities. Careful examination, however, revealed slight weakness in one or more groups of muscles.

Group III—Individuals with severe paralysis of one extremity and/or moderate paralysis of other extremities. These impairments were such that with the aid of braces, crutches, or other supports the patient was able to get around relatively well.

Group IV—Individuals with severe paralysis of two or more extremities. These involvements were such that the patient was not (or would not be) bedridden but, even

TABLE 6

Distribution of Survivors Reëxamined According to Original Diagnosis; Poliomyelitis, Cuyahoga County, 1941

Original Diagnosis	Total	Reëxamined	Per cent of Each Type Reëxamined	Per cent Distribution	
				Total	Reëxamined
Spinal	97	84	86.6	56.1	61.3
Bulbospinal	23	15	65.2	13.3	11.0
Bulbar	20	17	85.0	11.5	12.4
Abortive	33	21	63.6	19.1	15.3
Total	173	137	79.2	100.0	100.0

with the use of the proper supports, had (or would have) only limited activity.

Group V—Individuals with such severe paralysis of their extremities that they were bedridden.

Examinations were completed on 137, or 79 per cent, of the 173 survivors. The distribution of survivors according to original diagnosis and number of each type examined is shown in Table 6.

Sufficiently large proportions of individuals who had each type of disease were reëxamined so that the findings should be fairly representative of the condition of all survivors. If anything, the results should show a smaller proportion of individuals with minimal or no weakness than if all had been examined; for, from telephone conversations with the survivors who were not examined or with some member of their family, it was determined that none was bedridden and that all were up and about. The excuses for not coming in for examination were that the parents did not want to take the child from school; or they did not think the child needed an examination; or, in the case of several adults, that they did not wish to take time off from work.

Two other individuals, one a previous spinal case and the other an abortive, had died from causes other than poliomyelitis since their discharge from the hospital. The causes of death, as given on the death certificates, were a retroperitoneal sarcoma for the former and a fractured skull for the latter.

Results of examinations—The following is the classification of the 137 reexamined survivors according to extent of paralysis:

		Number	*Per cent*
Group I	normal	7	5.1
Group II	minimal paralysis	77	56.2
Group III	moderate paralysis	38	27.7
Group IV	severe paralysis; not bedridden	10	7.3
Group V	severe paralysis; bedridden	5	3.7
Total		137	100.0

Thus, 5 per cent of the survivors examined were normal and an additional 56 per cent had practically full use of all extremities and could walk normally and unaided. It was considered that with occasional visits to an orthopedist the slight defects found in the latter group could probably be corrected.

The physical impairments of many of those in Group III could likewise be overcome to a large extent by proper treatment. In 15 of these, in whom the damage was limited to a lower extremity, no artificial aid was needed although all walked with a limp. Another who had minimal paralysis of all extremities walked unaided. In 4 the paralysis was limited to one arm, and 1 of these wore a support; 1 wore a corset for support of paralyzed abdominal muscles, and 2 who were still receiving hospital treatment will walk with the aid of crutches or braces when discharged. The remainder walked with the aid of the following: 7 with braces on one leg, 3 with crutches, 3 with braces and crutches, 1 with a cane, and 1 with shoe correction.

The individuals in groups IV and V (11 per cent) were the more seriously affected survivors of the epidemic. They will probably always be seriously impaired or bedridden.

Condition by original diagnosis—In Table 7 the condition of the survivors at reëxamination is related to their original diagnosis.

Although the bulbospinal and bulbar types caused high fatality rates the survivors made good recoveries. Of 15 who survived the bulbospinal type only 1 was bedridden (Group V), 4 were classified in Group III, and 10 had recovered with only minimal weakness (Group II). Among those of Groups II and III there are included 3 who had impairment of muscles of face and deglutition, 1 of muscles of face, speech, and deglutition, 1 of muscles of face and speech, and 1 of facial muscles only. Of 17 who survived the bulbar

TABLE 7

Condition of Survivors at Reëxamination in February-March, 1942, According to Original Diagnosis; Poliomyelitis, Cuyahoga County, 1941

Original Diagnosis	Condition at Reëxamination: I Normal	II Minimal Paralysis	III Moderate Paralysis	IV Severe Paralysis	V Bedridden	Total
			Number			
Spinal	2	35	33	10	4	84
Bulbospinal	..	10	4	..	1	15
Bulbar	1	16	..	..	..	17
Abortive	4	16	1	..	..	21
Total	7	77	38	10	5	137
			Per cent			
Spinal	2.3	41.7	39.3	11.9	4.8	100.0
Bulbospinal	...	66.7	26.7	...	6.6	100.0
Bulbar	5.9	94.1	...	...	...	100.0
Abortive	19.0	76.2	4.8	...	...	100.0
Total	5.1	56.2	27.7	7.3	3.7	100.0

type 1 was normal and 16 had only minimal weakness. Although none of these was found to have had spinal paralysis during the acute phase of the illness, upon reëxamination 6 showed weakness of muscles of limbs or trunk only, 9 weakness of these muscles in addition to those of deglutition and speech, and 1 of the muscles of the eye.

The spinal type of the disease, which claimed no fatalities, was responsible for all of the severely paralyzed (Group IV) and 4 of the 5 bedridden.

It is instructive that only 4 of 21 who had abortive attacks were normal (Group I). One was found to have had paralysis of the abdominal muscles for which a corset must be worn, and the remaining 16 individuals were all found to have had minimal impairments of abdominal and various other muscles.

Condition by age — The percentage of recoveries (Groups I and II) was higher in individuals under 20 years of age than in those above this age. Sixty-five per cent of the persons who were under 10 years of age at the time of attack and 66 per cent of those from 10 to 19 years of age recovered with no serious paralysis. Only 31 per cent of survivors of 20 years of age and over recovered to this extent. Because of the small number of cases this finding and the higher case fatality rate for persons of 20 years of age and over, might separately be regarded as of doubtful significance. Taken together they point to the greater severity of the epidemic among adults.

III. PROBABILITY OF ATTACK WITH RECOVERY, PARALYSIS OR DEATH

Poliomyelitis is the most feared of all epidemic diseases. Parents dread not only the possibility of a fatal outcome but also that their children may be struck suddenly by a disabling paralysis. This fear might be tempered if two facts were emphasized more generally. First, only a small proportion of the population is ever attacked by the disease. In the largest epidemic this country has experienced, that in New York City in 1916, only 2 per 1,000 of the population was attacked. In the 1941 epidemic in Cuyahoga County, the largest in its history, the attack rate was only 15.5 per 100,000, or 0.15 per 1,000. Second, fatal or severely crippling attacks occur very infrequently. Even in the younger age

TABLE 8

Chances per 100,000 Population of an Individual Having an Attack of Poliomyelitis and That the Sequel 4 to 6 Months Later Would Be (a) Minimal or No Paralysis, (b) Moderate Paralysis, (c) Severe Paralysis, (d) Death
Cuyahoga County, 1941

Age (Years)	Minimal or No Paralysis (Groups I & II)	Moderate Paralysis (Group III)	Severe Paralysis (Groups IV & V)	Death (Group VI)	Total
Under 10	38.0	15.3	3.3	5.3	61.9
10–19	23.4	8.0	3.0	3.5	37.9
20 and over	0.6	0.8	0.6	0.3	2.3
Total	9.0	3.8	1.3	1.4	15.5

groups the risks are much smaller than is generally appreciated. The findings of this epidemic may be used to illustrate this point.

In a preceding section, 137 survivors have been classified into five groups according to their condition at reëxamination from 4 to 6 months after onset. Thirty-six individuals who did not report for reëxamination may be distributed, on the basis of their hospital discharge records and of other facts which have been learned, into these groups as follows: group II, 25; group III, 8; group IV, 1; and dead 2. The status of all who were attacked in this epidemic can therefore be estimated with a fair degree of accuracy as follows:

Groups I and II (normal or minimal paralysis) 109, or 57.7 per cent; group III (moderate paralysis) 46, or 24.4 per cent; group IV (severe paralysis; not bedridden) 11, or 5.8 per cent; group V (bedridden) 5, or 2.6 per cent; and group VI (dead) 18, or 9.5 per cent.

By distributing the above figures by age and relating them to the populations in the various age groups, it is possible to determine the probability of an individual having an attack of poliomyelitis that within 6 months after onset would result in (a) no or minimal paralysis, (b) moderate paralysis, (c) severe paralysis, or (d) death.

These probabilities in terms of chances per 100,000 population are presented in Table 8.

In the age group most affected by the disease (under 10 years of age) the chances of an attack in which the sequel would be minimal or no paralysis was 1 in 2,600; moderate paralysis 1 in 6,500; severe paralysis 1 in 30,000; and death 1 in 19,000. With advancing age these probabilities decreased greatly. For those in the age group 20 years and over they were for minimal or no paralysis 1 in 166,000; moderate paralysis 1 in 125,000; severe paralysis 1 in 166,000; and death 1 in 333,000. It should be realized that these probabilities are approximate only and will vary somewhat from epidemic to epidemic.

REFERENCES

1. Dauer, C. C. Prevalence of Poliomyelitis in the United States in 1941. *Pub. Health Rep.*, 57: 710, 1942.
2. Megrail, E., and Beall, N. P. Anterior Poliomyelitis in Cuyahoga County, July-October, 1937. *Bull. Acad. Med. Cleveland* XXII, 3: 8–9, 1938.
3. Wells, M. W. *Poliomyelitis. International Committee for the Study of Infantile Paralysis.* Chap. VII. Williams & Wilkins, 1932.
4. Davis, J. D., Weber, F. J., and Arey, M. S. A Clinical Study of Poliomyelitis in Charleston County, South Carolina, 1939. *Pub. Health Rep.* 56:1007–1017, 1941.
5. Toomey, J. A., Takacs, W. J., and Tischer, L. A. Poliomyelitis Virus from Flies. *Proc. Soc. Exper. Biol. & Med.*, 48:637–639, 1941.

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A Food-Borne Streptococcus Outbreak

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IN July, 1941, there occurred in a rural town * in eastern Massachusetts, an unusual outbreak of scarlet fever. On July 29, 2 children in a household engaged in milk production were diagnosed as cases of scarlet fever. Since there had been no scarlet fever in this community for several months and since the children had not been out of town, and the only affair attended by them was a church lunch on July 27, the source of the infection was undetermined, and they were removed to an isolation hospital. On the following day, July 30, 5 more cases were reported from a neighboring city and all of them had attended the same church reunion in this town on July 27. It was at once obvious that something unusual had occurred at the Sunday meeting and an investigation was immediately started.

ANALYSIS OF CASES

The church reunion, an annual affair, was attended by an estimated 200 people from the town, from many other municipalities in Massachusetts, and from several other states. The exact number could not be ascertained, as only about 100 registered; many did not arrive until after church services, and not all who attended the services remained for the refreshments. The names of persons attending were obtained principally from the minister's family and from the ladies who served the refreshments. The investigation was divided into two portions. The first part was performed in the town and the neighboring municipalities by the personnel of the Division of Communicable Diseases of the Massachusetts Department of Public Health. The second portion of the investigation, in distant towns, was performed by other departmental personnel, by local health departments, and by other state health departments. Histories were obtained on all persons who could be located from the list of those present at the affair and on others who became involved in the outbreak by eating the left-over refreshments. In all, 182 case records were obtained; 144 of these attended the Sunday meeting and the remaining 38 did not attend. Of the 144 who attended, 82 were ill, an attack rate of 56.9 per cent. Of those not attending, 20 were ill, an attack rate of 52.6 per cent. Of the total 182 investigated, 102 were ill, an overall attack rate of 56.0 per cent.

The sex of 172 people was known; 99, or 57.5 per cent, were females. Of the 102 patients, 63, or 61.7 per cent, were females; there being no significant statistical difference in the attack rates of the two sexes. Similarly, there was no statistical difference in the attack rates in the different age groups, particularly when the small number of cases in each group is considered.

* U. S. Census—1940—2,275.

TABLE 1

Age Distribution

	Age in Years					
	0–19		*20 and Over*		*Total*	
	No.	*Per cent*	*No.*	*Per cent*	*No.*	*Per cent*
Not Sick	10	21.3	37	78.7	47	31.5
Sick	26	25.4	76	74.6	102	68.5
Totals	36	24.2	113	75.8	149	100.0

Of the 102 patients, 24 developed frank scarlet fever (Table 2), 56 sore throats, 7 diarrhea, 4 vomiting, 3 nausea, and 8 miscellaneous complaints. These groups are mutually exclusive and the patient is listed in each category according to the most severe complaint taken in this order. Eighty of the patients developed infection with the streptococcus, as well as toxemia, as manifested by the frank scarlet fever and the sore throats. Gastroenteric symptoms were predominant among these patients, suggesting the presence of an enterotoxic substance.

TABLE 2

Complaints of Patients

Complaint	*Male*	*Female*	*Both Sexes*	*Per cent of Total Ill*
Scarlet Fever *	11	13	24	23.5
Sore Throat	20	36	56	54.9
Diarrhea	2	5	7	6.8
Vomiting	1	3	4	3.9
Nausea	1	2	3	2.9
Miscellaneous	4	4	8	7.8
Total	39	63	102	99.8

* These groups are mutually exclusive

Although the age distribution for the two groups as a whole was the same, 16 cases of scarlet fever occurred under 20 years of age and 8 cases occurred in patients 20 or over. Among the sore throat patients, however, only 6 were under 20, whereas 50 were 20 years of age or over. This distribution is explained by the lack of immunity to the erythrogenic toxin of the streptococcus in the younger age group, and is in accord with the usual experience in other streptococcus outbreaks.

The food served after the service consisted of coffee and cream, a variety of home-made cakes contributed by the ladies of the church, and ground ham sandwiches. Drinking water was served to only a few individuals and came from the private supply of a nearby home. Some of those drinking the water were ill and some were not; however, no one was found to be ill who had drunk only the water and had nothing to eat. Moreover, there was no illness in the home where the water was obtained.

The investigation revealed (Table 3) that all persons who were ill, with one exception, had eaten either ham sandwiches or ground ham. Since only 30 per cent of those ill had drunk the coffee, and only 35 per cent had eaten of about 20 home-made cakes, there was no doubt that the illness was correlated with the ham. However, not all persons who had eaten the ham sandwiches were ill. The attack rate among those who ate the sandwiches was 72 per cent.

Of the 140 persons who ate the ham, 4 ate it immediately after it was cooked on Friday night, July 25, and none of these became ill. One hundred and

TABLE 3

Per cent of Persons Eating Foods Served at Church Reunion

	102 Sick Persons		*47 Persons Not Sick*		*149 Total Persons*	
Food	*No.*	*Per cent*	*No.*	*Per cent*	*No.*	*Per cent*
Coffee	31	30.3	24	51.0	55	36.9
Cake	36	35.3	31	65.9	67	44.9
Ham sand. or ground ham	101 *	99.0	39	82.9	140	93.9

* Only one case did not eat the ham; she was a contact of the case which was responsible for the contamination of the food.

sixteen ate ham sandwiches at the meeting about 36 hours later, and 82 of these became ill; an attack rate of 70.6 per cent. Fourteen others ate the left-over sandwiches brought home from the meeting; 13 of these became ill, an attack rate of 92.8 per cent. Six other individuals ate some of the ground ham, which had been left over from making the sandwiches; this ham was eaten late Sunday or on Monday, July 28, either as fried ham patties or as ham sandwiches. All of these individuals became ill; giving an attack rate of 100 per cent. There is, thus, definite evidence that the attack rate increased with the passage of time and it may be assumed the toxicity of the ham increased correspondingly.

PREPARATION OF THE HAM

The bread used in the sandwiches consisted of about twenty-five loaves of sliced white bread wrapped in wax paper. The other ingredient of the sandwiches was a commercial mayonnaise which was spread on the bread at the time that the sandwiches were made. Since some of the persons who became ill ate only the ham, the other ingredients of the ham sandwiches are automatically eliminated as possible sources of infection. The ground ham consisted of meat derived from two separate 18 to 20 lb. smoked hams, which were purchased from a local meat packing establishment which had been processing a high grade of hams and bacon for over 93 years.

These hams had been purchased by the local processing house from a large concern in Boston, their usual source of meat, and were part of a 300 lb. shipment. These hams had been cured in St. Louis and were shipped from Boston in covered barrels to the local concern, where they were kept in a frozen state for about 1 week, then thawed and hung in the smokehouse for 30 hours. Hickory and walnut wood were used for the production of the smoke. At the end of the smoking time, the hams were removed and hung to cool for 2 hours and then sold to the church committee which had ordered them on July 25. One ham was taken by Mrs. A. and the second by Mrs. B. There was no illness among other customers who purchased products from this concern.

These two ladies had cooked hams for the annual church reunions for about 8 years. Upon receiving the ham, Mrs. B. cut it into halves and placed each piece in a covered pan with enough water to cover the meat. The pans were placed over a bottled gas flame and the water was kept boiling from 9:30 a.m. to 3:30 p.m. on Friday. The ham was then removed from the water and the latter thrown away. The cooking utensils were covered aluminum kettles. When the ham was taken from the cooking vessels, it fell off the bones and was exceedingly tender. It was boned by Mrs. B. and placed in an earthenware vessel to cool and then put into a mechanical refrigerator over night. At about 10 a.m. on Saturday, July 26, it was ground on a household meat grinder which had not been used for at least a week previously and the

ground meat was replaced in the same earthenware vessels, covered with oiled paper and placed in the refrigerator. That Saturday noon, Mrs. B. made two sandwiches for herself and her husband. Mrs. C., daughter-in-law of Mrs. B., and her husband, also ate some of the ham Friday night. At the church gathering on Sunday, both Mr. and Mrs. B. ate ham sandwiches and became ill with nausea and vomiting 3 hours later.

Mrs. A. who received the second ham placed the entire ham in an "Army Cannon Boiler" with a cover. She placed this boiler over an asbestos pad which was placed over the bottled gas flame. The water which covered the ham was brought to a boil and then the gas flame was turned down so that the water simmered. The ham was started to cook at 8:15 a.m. on Friday and kept at a simmering temperature to 12:30 p.m., when the flame was turned off. Mrs. A. was able to pull a spoon-like bone out of the large end of the ham and considered this a sufficient test to determine that the ham was properly cooked. Mr. A. had cut off a slice of ham about as large as an ordinary slice of bread and about ¼ inch thick and made a sandwich which he ate for his supper Friday night. He also attended the church gathering on Sunday and ate a ham sandwich and had some coffee, but was not sick.

After the ham was cooked by Mrs. A., she was visited by her daughter, Mrs. D., and her two grandchildren, age 4 and 5. Mrs. A. served her three visitors with a piece of ham, each receiving a slice of sufficient breadth to fit about ½ slice of bread and about ¼ inch in thickness. This slicing of the ham took place between 7 and 8 p.m. on Friday night. Neither Mrs. D. nor either of her two children was ill; and they did not attend the church nor did they eat the ground ham. The ham was left in the water all night and was removed at 7:30 on Saturday morning. It was deboned and ground by her and her husband in a household grinder. The ground meat was placed in two earthenware bowls and taken to the church at about 2:00 p.m. on Saturday.

The two hams, cooked and ground by Mrs. A. and Mrs. B., were brought to the church on Saturday, where a distinct difference was noted between the meat from the two hams. The ground ham cooked by Mrs. A. was lighter in color and very moist; the ladies decided to mix this light, moist meat with the comparatively dry and dark meat of the ham cooked by Mrs. B. This mixing was done on each individual sandwich and not in one large bowl. A commercial salad dressing was applied to the bread at the time the sandwiches were made.

After the sandwiches were prepared by the church ladies, they were carefully wrapped in wax paper and placed in a large metal boiler which was left standing in a room in the basement of the church. On Sunday after the church service, these sandwiches and the other refreshments were served on the lawn outside the church. For approximately twenty-four hours, the ham sandwiches were at room temperature on July 26 to July 27. The maximum and minimum temperatures on these days, as recorded by the U. S. Weather Bureau for the neighboring town of Concord, were 89° and 64° on July 26 and 86° and 57° on July 27, 1941.

Mrs. A., who had prepared one of the hams, was perfectly well until Sunday, when she felt ill and as soon as the church services were over, she went home without staying for refreshments. Upon reaching home, she vomited profusely and developed diarrhea. On Monday, July 28, she awoke to find herself covered with a very red rash, which was diagnosed as a frank case of scarlet fever.

Some of the ground ham prepared by Mrs. A. was left over when the sandwiches were made, and a pound of this was sold to Mrs. McD.; this ground ham had not been mixed with the commercial dressing nor with the ham prepared by Mrs. B. Mrs. McD. had not eaten any of the ham sandwiches while they were being prepared nor at the church gathering. After the church service, Mr. and Mrs. McD. returned home, fried four ham patties, using Mrs. A.'s ground ham mixed with cracker crumbs, egg and onion. These were broiled lightly for Sunday lunch. About three hours later, both became extremely ill with nausea, vomiting and diarrhea.

Mrs. S., another woman who helped to prepare the sandwiches, purchased a half pound of ham cooked by Mrs. B. and ate it Saturday night. She also ate some of the sandwiches during the church gathering on Sunday. On Tuesday she developed an extremely sore throat. Mrs. T., however, who had also purchased some of the ham prepared by Mrs. B., ate the ham Saturday night, but did not eat any sandwiches at the church gathering and was not ill.

SOURCE OF INFECTION OF THE HAM

The evidence, as noted, indicates that Mrs. A. was in the early stage of scarlet fever at the time she handled the ham which she prepared. On Friday, about 7 hours after the flame was turned off under the boiler containing the ham immersed in the water, she removed it and cut several slices from it to feed her visitors; and thereafter replaced the ham in the water. Since only the ham which she prepared was responsible for the outbreak, it is assumed that she infected the meat, either directly by her respiratory discharges or indirectly by her hands which had become soiled by the respiratory discharges. The warm media (ham still in water overnight) incubated the streptococcus for about 12 hours and permitted the formation of the enterotoxic substance. Persons who ate the ham while preparing the sandwiches became ill, but not so severely nor with such a high attack rate as those who ate the ham after it was left at room temperature for another 24 hours, thereby permitting further growth of the hemolytic streptococcus and further elaboration of the enterotoxic substance.

Cultures were taken from Mrs. A.'s throat, from some of the ham prepared by Mrs. A. and purchased by Mrs. McD., and from the throats of 14 patients. The cultures of 9 of the patients, of Mrs. A., and of the ham were positive for hemolytic streptococci.

The hemolytic streptococci isolated from all these sources were identified as Lancefield Group A, Griffith Type 2. Since ham was the original vehicle of infection, the hemolytic streptococci were cultured in sterile, ground ham in an attempt to demonstrate the production of enterotoxic substances. Sterile filtrates of such cultures contained substances which were enterotoxic when injected intravenously in kittens, while filtrates of uninoculated ham were consistently negative. Similarly, toxic filtrates could be prepared from ground ham and other tissue media inoculated with various bacteria. Comparative studies with erythrogenic toxins prepared from the same strains indicated that the enterotoxic substance was distinct from erythrogenic toxin. Nonbacterial agents such as trypsin, papain, lactic acid, and sodium hydroxide also produced toxic substances in tissue media.

The toxic substance in filtrates of such cultures was dialyzable and could be precipitated with alcohol. The active fractions and whole filtrates were heat stable and resisted a relatively wide range of pH values. Biuret, Millon, and Molisch tests with the fractions and whole filtrates were positive.

Despite the similarity of symptoms produced in kittens, the substances in filtrates of tissue cultures were distinct from staphylococcus enterotoxin. Staphylococcus enterotoxin could be produced in media such as casein hydrolysate which contained no tissue proteins. Cultivation of the hemolytic streptococci in such media did not yield a toxic filtrate. The production of staphylococcus enterotoxin is not inhibited by anaerobic conditions, whereas anaerobic incubation of the tissue media prevented the production of toxic filtrates. Digestion with proteolytic enzymes destroyed the toxicity of tissue filtrates but did not affect staphylococcus enterotoxin. Oral administration of the staphylococcus enterotoxin and the ham filtrate to kittens revealed that only the former produced a reaction, per os.

Some data were obtained which suggest that the proteins in the tissue media were split into toxic amines by the action of enzymes associated with bacterial metabolism. A detailed report of these bacteriological studies is to be published elsewhere.[10]

DISCUSSION

Food-borne diseases can be divided into two main divisions: (1) food infection, when the etiological agent is a living organism and the symptoms are the manifestation of the reaction of the host to the action of the infecting organism, and (2) food poisoning where the causative agent is a noxious substance which in itself is responsible for the characteristic clinical sequence. The etiological agent of food infection may be a virus, bacterium, protozoan, or helminth. Food poisoning on the other hand may be divided into two groups: (1) endogenous poisons, which are usually present in the food, and (2) exogenous poisons which are not an integral part of the food but are present as an addition to the food. These exogenous poisons may be organic substances, such as the exotoxin of the *Clostridium botulinum*, or an inorganic compound such as sodium fluoride.

In this outbreak, gastrointestinal symptoms were outstanding in prevalence. Dick states that the first symptom of scarlet fever is a sore throat which is followed in a few hours to a few days by the sudden onset of toxic symptoms, almost always with nausea and vomiting, and sometimes diarrhea. Stimson speaks of a triad of fever, sore throat, and vomiting, as characteristic of the onset of scarlet fever. However, an analysis of 50 consecutive cases of scarlet fever treated at Belmont Isolation Hospital, in Worcester, Mass., revealed that only 20 cases (40 per cent) experienced nausea and vomiting and only 1 case developed diarrhea. In an analysis of an additional 50 consecutive cases of scarlet fever prior to hospitalization in the city of Worcester, it was found that only 12 cases (24 per cent) developed nausea and vomiting and 2 cases experienced diarrhea. The majority of these cases were due to Lancefield Group A, Griffith Type 2 streptococcus. It would seem, therefore, that scarlet fever is not as frequently characterized by gastrointestinal symptoms as reported by some authors. Even if nausea and vomiting are accepted as characteristic of scarlet fever, these symptoms were unusually prevalent in this outbreak. Nearly all of the persons with scarlet fever and septic sore throat were afflicted with nausea, vomiting, and diarrhea; and in many instances severe gastroenteritis occurred without any symptoms of sepsis or toxemia due to the erythrogenic toxin. The literature of food-borne outbreaks of scarlet fever and septic sore throat does not emphasize, and in some instances does not even mention, the occurrence of gastrointestinal symptoms. Many of these outbreaks, however, were transmitted

by milk. It is possible that ham provides a medium which is more favorable for the production of the enterotoxic substance as observed in this outbreak and in the laboratory procedures described.

SUMMARY

A ham-borne outbreak involved 24 cases of scarlet fever, 56 cases of septic sore throat, 7 of diarrhea, 4 of vomiting, 3 of nausea, and 8 with miscellaneous complaints as herewith reported. One of the hams was cooked by a woman who herself was in the early preëruptive stage of scarlet fever. Gastrointestinal symptoms were predominant. Laboratory analysis revealed Lancefield Group A, Griffith Type 2, hemolytic streptococci from the ground ham, from the throat of the food handler, and from the throats of 9 cases. The production of an enterotoxic substance from a ham substrate is discussed.

BIBLIOGRAPHY

1. Jordan, E. O. *General Bacteriology*. 11th Ed. Saunders, 1935, pp. 211—212.
2. Dack, G. M. *Food Poisoning*. U. of Chicago Press, 1943, pp. 138.
3. Getting, V. A. Some Epidemiological Considerations of Food-Borne Disease. *New Eng. J. Med.*, 228:754–761 (June 10), 1943; 788–795 (June 17), 1943; 823–829 (June 24), 1943.
4. Dick, George F., and Dick, Gladys Henry. *Scarlet Fever*. Year Book Publishers, Chicago, Ill., 1938, pp. 149.
5. Stimson, Philip Moen. *A Manual of the Common Communicable Diseases*. 3rd Ed. Lea and Febiger, 1940, pp. 465.
6. Scammon, C. L., Lombard, H. L., Beckler, E. A., and Lawson, C. M. Scarlet Fever Outbreak Due to Infected Food. *A.J.P.H.*, 17:311–316 (Apr.), 1927.
7. Nelson, N. A. An Outbreak of Gastro-Intestinal Disturbance Following Eating of Chocolate Cream Pie. *New Eng. J. Med.*, 199:1145–1148 (Dec. 6), 1928.
8. Cary, W. E., Dack, G. M., and Myers, E. Institutional Outbreak of Food Poisoning Possibly Due to Streptococcus. *Proc. Soc. Exper. Biol. & Med.*, 29:214–215 (Nov.), 1931.
9. Jordan, E. O. Staphylococcus Food Poisoning. *J.A.M.A.*, 97:1704–1707 (Dec. 5), 1931.
10. Jordan, E. O., and Burrows, W. Streptococcus Food Poisoning. *J. Infect. Dis.*, 55:363–367, 1934.
11. Dublin, T. D., Rogers, E. F. H., Perkins, J. E., and Graves, F. W. Milk-borne Outbreaks Due to Serologically Typed Hemolytic Streptococci. *A.J.P.H.*, 33, 2:157–166 (Feb.), 1943.
12. Final Report on Milk-Borne Septic Sore Throat Outbreak in Suffolk County. *Health News*, New York State Dept. of Health, 19, 6:23 (Feb. 9), 1942.
13. Scarlet Fever in Delaware County Traced to Raw Milk. *Health News*, New York State Dept. of Health, 19, 19 (May 11), 1942.
14. Bloomfield, A. L., and Rantz, Lowell A. An Outbreak of Streptococcus Septic Sore Throat in a Camp. *J.A.M.A.*, 121:315–318 (Jan. 30), 1943.
15. Hammon, W. M. Staphylococcus Enterotoxin: An Improved Cat Test, Chemical and Immunological Studies. *A.J.P.H.*, 31:1191–1198 (Nov.), 1941.
16. Foley, G. E., Wheeler, S. M., and Getting, V. A. A Food-borne Streptococcus Outbreak: The Differentiation of Staphylococcus Enterotoxin from Toxic Substances Produced in Minced Tissue Media by Hemolytic Streptococci and Other Agents. *Am. J. Hyg.*, Nov., 1943.

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Illness Caused by Cadmium

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OUTBREAKS of food poisoning attributed to ingestion of food contaminated with cadmium have been reported by Frant and Kleeman,[1] Cangelosi,[2] and the National Institute of Health.[3] These foods were found to be acid in nature and were made or kept in cadmium plated utensils with a resultant solution of the cadmium by the acid food.

Recent investigations by the Department of Health of the City of New York indicate that food need not be in direct contact with cadmium plated utensils to become contaminated and cause food poisoning. Refrigerator evaporators, broiler grids, and other utensils have been cadmium plated and are more widely distributed than heretofore suspected. The following two incidents illustrate some of the recent findings in regard to such equipment:

1. On August 11, 1942, a reported food poisoning outbreak involving 3 members of a family was investigated. Severe vomiting, the only symptom, occurred within 1 hour after the meal eaten in common (supper). Recovery occurred in all cases within 3 hours. Lemonade was served at this meal; none was available for examination, but the other foods eaten in common were negative upon chemical and bacteriological examination. Lemonade was prepared in a glass pitcher, and cooled by the addition of ice cubes. The ice cube trays in the refrigerator were found to be made of aluminum.

2. On August 22, 1942, a food poisoning outbreak involving 4 members of a family was investigated. Severe vomiting occurred ½ hour after all 4 had consumed root beer to which ice cubes had been added. The root beer was the only food taken in common. No root beer was available for examination. Duration of illness was short with rapid recovery. A chemical poisoning was indicated. Investigation revealed that the ice cubes had been made in a defective refrigerator with a sulfur dioxide leak. A sample of ice cubes contained 769 p.p.m. of cadmium. The ice cube trays were made of aluminum.

Thus in the above two groups of food poisonings we had a reasonable suspicion in the first and a definite indication in the second that cadmium was involved, without any evidence of the preparation of food in a cadmium plated utensil. Subsequent investigation revealed that in the first group, cadmium flakes had dropped into the ice cube trays from the evaporator unit which was cadmium plated and was scaling. The investigation of the second group revealed that the sulfur dioxide refrigerant leaked and caused the refrigerator to defrost. The evaporator was cadmium plated. The moisture on the evaporator dissolved the sulfur dioxide, and the resultant acid, reacting with the cadmium on the evaporator, dissolved some of it. The acid solution of cadmium dripped into the ice cube trays, accounting for the presence of cadmium in the ice cubes. These incidents show that the cadmium plated vessels need not be in direct contact with food to be dangerous and to produce illness.

The refrigerators in both of these

cases were made by the same manufacturer. The evaporators were made of steel and had been originally plated with tin. During the guarantee period, the evaporators became rusted and were removed and sent to several platers within this city, with the specific instructions that they be cadmium plated. This manufacturer's service representative also advised several other refrigerator service men and dealers where such plating could be done satisfactorily.

The records of one electroplater revealed that at least 3,000 evaporators had been plated with cadmium for this manufacturer between 1937 and 1939. Cadmium plating had been done for many refrigerator dealers outside of New York City. The investigation led from one electroplater to another. Their records showed that cadmium plating had been done for refrigerator service men, apartment house owners, realty management companies, and private citizens, on refrigerator evaporators, refrigerator grids or shelves, broiler grids used in gas ranges, and various other utensils which do not normally come in direct contact with food. In two specific instances servicemen had asked for tinplating and got cadmium instead. The plating industry had been notified and advised previously by the Department of Health that the use of cadmium is dangerous and that the metal should not be used on food utensils and equipment.

The extent to which cadmium is used as a plating material makes a field test for cadmium a valuable aid. An acid field test is available, but was found to be unreliable. This test consists of placing a drop of dilute hydrochloric or acetic acid on a surface suspected of being cadmium plated, and adding a drop of sodium sulfide. This forms a canary yellow color if cadmium is present. While this test is useful as a screening method to distinguish between clean aluminum and cadmium plated surfaces, on surfaces such as evaporator units, which are often corroded, this test is of doubtful value because of the presence of interfering metals, particularly, tin, iron, nickel, and silver.

Goldstone [5] devised a method which is performed easily in the field and which eliminates these interferences. This method is a refinement and adaptation of the laboratory method proposed by Coleman.[6]

It requires the following reagents:

1. *Ammonia—Sodium Nitrate Reagent*
   200 ml. of ammonia water (28 per cent) plus 100 gm. of sodium nitrate diluted with water to 1 liter volume
2. *Sodium Sulfide Reagent*
   100 gm. of sodium sulfide diluted with water to 1 liter volume
3. *Potassium Cyanide Reagent*
   100 gm. of potassium cyanide diluted with water to 1 liter volume.

The test is performed as follows:

To a small pinch of the metal scrapings in a test tube, add 3 ml. of the ammonia-sodium nitrate reagent; bring the mixture to a boil over a flame and allow to stand for a minute or two. Pour the clear supernatant liquid into another test tube, add 1 ml. of the cyanide reagent and, after shaking, add 1 drop of sodium sulfide reagent. This produces a canary yellow precipitate if cadmium is present. The metals, iron, tin, antimony, arsenic, silver, copper, nickel, chromium, zinc, and aluminum do not interfere. In the case of zinc or aluminum, a whitish gray precipitate is formed which is readily distinguishable from the canary yellow color of cadmium sulfide. If cadmium is present in addition to any of these metals, it is instantly detected. The only metals which do interfere are lead and mercury, but these are rarely, if ever, used as plating metals under these conditions.

With the aid of this field test, a survey was made of 20 apartment houses which were equipped with suspected

refrigerators. Scrapings were taken from 104 evaporators in refrigerators in use in these apartment houses. These were tested in the field. It was revealed that 25 per cent of the number of refrigerators tested had cadmium plated parts. Samples of scrapings from 26 mechanical refrigerators where the field test indicated cadmium, were obtained and were analyzed in the chemical laboratory of the Bureau of Food and Drugs. The findings of the field test were confirmed in all cases. Control samples were also taken. The survey was extended to refrigerator repair shops, and second-hand refrigerator dealers. Here, too, cadmium plated evaporators were found. One cadmium plated evaporator was found which had been sent to New York City from a dealer who had a surplus stock in Chicago.

Conferences were held with the manufacturer of the refrigerator involved, with realty management companies, and apartment house operators using second-hand or repaired refrigerators, to acquaint them with the problem. Representatives of these companies were taught how to perform the field test, and the companies were charged with the responsibility of checking their refrigerators for cadmium plating and for rendering them safe by deplating if cadmium was found.

Cadmium as a metal is on the priorities list and its use for plating food and beverage containers is not permitted. Evaporators, refrigerator shelves, and broiler grids for gas stoves are not regarded as food containers, but if these parts of equipment are cadmium plated, food poisoning may take place.

SUMMARY

Two outbreaks of acute cadmium poisoning are described in which 7 persons became ill with acute gastritis within ½ to 1 hour after partaking of drinks contaminated with cadmium. In contradistinction to cases reported in the past, the drinks were not in direct contact with cadmium plated utensils, but were contaminated by ice cubes exposed to drippings and scalings from cadmium plated evaporators of refrigerators. A survey of apartment houses with a newly developed field test, shows 25 per cent of the refrigerators of one manufacturer to be cadmium plated. The records of platers revealed refrigerator shelves and broiler grids had also been cadmium plated. Evidence obtained in this investigation points to the fact that this kind of plating is being done in other cities.

REFERENCES

1. Frant, S., and Kleeman, I. Cadmium Food Poisoning. *J.A.M.A.*, 117:86 (July), 1941.
2. Cangelosi, J. T. Acute Cadmium Metal Poisoning; report of 3 outbreaks. *U. S. Nav. M. Bul.*, 39:408–410 (July), 1941.
3. National Institute of Health, Division of Industrial Hygiene. Cadmium Poisoning. *Reprint No. 2371. Pub. Health Rep.*, 57, 17:601–612, 1942.
4. *Sanitary Code of the City of New York.* Section 145.
5. Goldstone, N. I., chemist, Bureau of Food and Drugs. Personal communication.
6. Coleman, S. A. Qualitative Detection of Zinc or Cadmium in Plating on Metals. *Chemist-Analyst*, 29:4 (Nov.), 1940.

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Biological Changes in Theiler's Virus of Spontaneous Mouse Encephalomyelitis*

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IN 1934, Theiler [1] isolated and described the virus which causes so-called "spontaneous" encephalomyelitis in mice. Subsequent investigations led to the discovery of a number of significant facts all of which pointed to a striking similarity between this mouse disease and the symptomatology, pathology, and epidemiology of human poliomyelitis.[2] The fund of knowledge which has recently accumulated from the study of human strains of poliomyelitis virus in experimentally infected rodents serves to supplement these earlier findings in a number of ways which will be briefly reviewed.

To begin with, comparison of the physical constants of simian [3] or of mouse-adapted [4] poliomyelitis virus with those of the virus of natural mouse encephalomyelitis [5] leaves an impression that all three viruses may be morphologically alike.

Second, it can be said that the pathological process which follows infection with the murine Lansing [6] or the murine SK [7] strains of human poliomyelitis virus is indistinguishable from that of Theiler's disease.[8] What seems perhaps more significant is the fact that, while there are important differences between murine and human poliomyelitis with regard to the type and distribution of nervous lesions, the classical picture observed in monkey and man is found again in guinea pigs which have been paralyzed by the cavian strain of SK poliomyelitis virus.[7]

Third, a number of facts may be related which suggest some antigenic relationship between Theiler's virus and mouse-adapted human poliomyelitis virus even though such a relationship cannot be demonstrated with simian poliomyelitis virus.[9] For instance, Theiler,[10] as well as Young and Cumberland,[11] reported that cotton rats or mice following survival from a paralyzing attack of mouse encephalomyelitis showed considerable protection against reinoculation with the murine Lansing strain. While the above authors failed to observe any corresponding cross-neutralization between the two viruses, serological analysis of the murine SK strain has revealed the existence of a broad, non-reciprocal immunological relationship which embraces all three viruses (RMV, SK, Theiler) that produce paralysis in man or mouse.[12]

The set of experimental results which has just been described finds further confirmation in certain epidemiological observations. Thus, recent investigation of a localized outbreak of poliomyelitis led to the isolation of two rodent-paralyzing agents, one from a child who had died of the disease, the other from a dead house mouse encoun-

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tered in the home of the same fatal case.[13] The two viruses, except for their different virulence in mice, possessed similar fundamental characteristics; in addition, both were neutralized by convalescent sera from surviving patients as well as by antiserum against Theiler's virus.

That the above mentioned observations indicate some intimate connection between the etiological agents of poliomyelitis in man and of Theiler's disease in mice, is a matter which can scarcely be denied. Against the flat assumption, however, that both are identical stands the fact that the two viruses are narrowly restricted, in their natural as well as in their experimental host range, to man or mouse, respectively. Despite the failure of direct transmission of poliomyelitis virus from monkey to mouse—or of Theiler's virus from mouse to monkey—it is well known that certain strains of monkey or human virus may be transferred to albino mice by means of intermediary passage through cotton rats or hamsters.[14] In view of the circumstances it has seemed of interest to explore the possibilities of adapting Theiler's virus, by serial cotton rat passage, from mice to other animal species, particularly monkeys and guinea pigs. The present communication sets forth in detail the results obtained in several such experiments.

EXPERIMENTAL WORK

The virus of spontaneous mouse encephalomyelitis used in this work was the so-called GDVII strain; it was received, in its 108th mouse passage, through the courtesy of Dr. Max Theiler from the Rockefeller Foundation. The virus was maintained in this laboratory in young Swiss albino mice by intracerebral transfer of 10 per cent brain suspensions obtained from paralyzed mice in serial passage.

Periodic titrations showed that this strain was highly virulent for young mice upon intracerebral injection (10^{-6} to 10^{-8}); however when injected by the intraperitoneal route its titer was considerably lower (10^{-1}). While the high intracerebral infectivity of the virus was well maintained over a long series of mouse passages, the degree of its peripheral invasiveness showed marked fluctuations, particularly with the advent of the summer months. Thus, between June and September of two successive years, the percentage of paralysis in mice which had been infected by the intraperitoneal route, dropped to about 10 to 20 per cent as compared with a level of approximately 90 to 100 per cent paralysis during the remainder of the year. The nature of this seasonal fluctuation is unknown.

Repeated attempts to infect guinea pigs, albino rats, or rhesus monkeys by intracerebral injection with large doses of this virus failed to produce any recognizable signs of disease. Nor was it possible to recover any active virus by sacrificing some of these animals at short intervals after injection and transferring the brain substance to albino mice.

Of three Syrian hamsters injected with the 121st or 123rd mouse passages, one animal showed paralysis of the left front leg after an incubation period of 7 days, another animal developed prostrating paralysis of both front and hind legs on the 3rd day after injection, a third hamster remained free from any symptoms. Further transmission of the infection to new hamsters proved impossible even though the presence of active virus in the brain could be demonstrated by re-transfer to mice.

Numerous experiments confirmed Theiler and Gard's original observation[15] that cotton rats are uniformly susceptible to the virus of mouse encephalomyelitis. All infected cotton rats, without exception, developed prostrating paralysis from 5 to 7 days after intracerebral injection, but no symptoms

TABLE 1

General Properties of Theiler's Mouse Encephalomyelitis Virus (GDVII Strain)

Mouse Passages	Neutralization by: Normal Adult Mouse Serum	Neutralization by: Normal Adult Cotton Rat Serum	Host Range of Pathogenicity: Albino Mouse i.c.	Albino Mouse i.p.	Cotton Rat i.c.	Cotton Rat i.p.	Hamster i.c.	Hamster i.p.	Albino Rat i.c.	Guinea Pig i.c.	Rhesus Monkey i.c.
109			10^{-7}	10^{-3}	2/2	0/1			0/2		
110					2/2	0/1					
111											0/1
112	+		10^{-6}	10^{-3}						0/6	
113	+										
114	+		10^{-5}	10^{-3}	1/1	0/1				0/2	
115	+			10^{-3}							
116	+	—	10^{-7}	10^{-3}	1/1	0/1				0/4	0/3
117											
118	+								0/2		
119											
120				10^{-3}							
121				10^{-3}		0/1	1/2	0/1			
122											
123				10^{-3}			1/1				
124				10^{-3}							
125	+			10^{-3}							
126			10^{-6}	10^{-3}							
127			10^{-7}	10^{-3}							
128	+		10^{-7}	10^{-3}							
129			10^{-8}	10^{-3}							
130			10^{-9}	10^{-3}							

Numerator = number of animals paralyzed
Denominator = number of animals injected

were produced by intraperitoneal injection of large doses of mouse virus. The disease thus initiated could be maintained in successive cotton rat passages by intracerebral transfer of infected cotton rat brain and cord.

The pertinent data relating to these preliminary tests are given in Table 1.

I. Transmission of Theiler's Virus from Albino Mice to Cotton Rats and the Establishment of Two Fixed Strains of Cotton Rat Virus

Experiment 1 (October 31, 1941): Theiler's virus was transferred to cotton rats by using the brain of a freshly paralyzed mouse from the 109th mouse passage. The virus was carried in cotton rats through 21 serial intracerebral passages over a period of 13 months. In the first 3 cotton rat passages the incubation period varied between 5 and 4 days, in the next 3 passages between 4 and 3 days, thereafter, it became fixed at 2 days. Transfers from paralyzed cotton rats to albino mice were carried out with the 1st, 2nd, 3rd, 6th, 9th, 15th, 17th, and 18th cotton rat passage; to guinea pigs with the 7th, 10th, 15th, 18th and 21st cotton rat passages; and to rhesus monkeys with the 3rd, 6th, 10th, and 15th cotton rat passages. Mice received the cotton rat virus by either intraperitoneal or intracerebral injection, monkeys and guinea pigs only by the intracerebral route. The results obtained with these transfers are brought together in Table 2.

It will be seen from Table 2 that the virus returned to mice from the first paralyzed cotton rat with titers of 10^{-3} intracerebrally, and 10^{-1} intraperitoneally, but that with subsequent cotton rat passages (2nd, 3rd, 6th, 9th, 11th, 15th, 17th, and 18th) intraperitoneal titers between 10^{-4} and 10^{-6} were regularly observed; intracerebral titers continued to run at the usual level of about 10^{-6}. Transfers to guinea pigs from earlier cotton rat passages (7th and 10th) produced no recognizable symp-

TABLE 2

Transmission of Theiler's Mouse Virus (109th Passage) to Cotton Rats
Experiment I

Cotton Rat Passage	Date	Incubation Period	Pathogenicity for: Albino Mouse i.c.	Albino Mouse i.p.	Guinea Pig i.c.	Rhesus Monkey i.c.
I	10–31–41	5 days	10^{-3}	10^{-3}		
II	11–7–41	5 days	10^{-7}	10^{-4}		
III	11–14–41	4–5 days	10^{-7}	10^{-6}		1 paresis arm (AJ 56) 1 fever
IV	1–3–42	3 days				
V	1–7–42	4 days				
VI	1–12–42	3 days		10^{-4}		1 fever
VII	1–27–42	2 days			2 negative	1 negative
VIII	1–31–42	2 days				
IX	2–4–42	2 days		10^{-5}		
X	2–7–42	2 days			2 negative	1 paresis leg (AK35) 2 fever
XI	2–25–42	2 days				
XII	2–27–42	2 days				
XIII	3–1–42	2 days				
XIV	3–3–42	2 days				
XV	3–5–42	2 days	10^{-7}	10^{-6}	4 paralyzed	1 paresis leg (AK93) 2 fever
XVI	3–3–42	2 days				
XVII	8–11–42	2 days		10^{-6}		
XVIII	9–8–42	1 day		10^{-6}	1 paralyzed	
XIX	10–14–42	2 days				
XX	10–16–42	2–3 days				
XXI	11–12–42	2 days			1 paralyzed	

toms, but virus harvested from later cotton rat passages (15th, 18th, and 21st) proved capable of paralyzing all injected guinea pigs. Transfers from paralyzed cotton rats to rhesus monkeys induced fever or pareses of the extremities in practically all monkeys which had received virus from early as well as late cotton rat passages (3rd, 6th, 10th, and 15th). Intracerebral injection of normal cotton rat brain into monkeys produced neither fever nor any other signs of disease. Attempts to reproduce the above symptoms in continued monkey passages were unsuccessful but the virus returned readily to mice. All monkeys surviving without symptoms proved fully susceptible to intracerebral reinfection with monkey poliomyelitis virus (Aycock strain).

The results obtained in this experiment suggest that Theiler's virus, after passage through cotton rats, had undergone a profound biological change. In other words, Theiler's cotton rat virus displayed in peripherally infected mice marked invasive properties and proved pathogenic for guinea pigs and rhesus monkeys upon intracerebral injection, characteristics which were not observed with Theiler's mouse virus. These new properties apparently were acquired as the result of a gradual adaptation in the cotton rat as the virus was passed serially in that animal. The adaptive nature of this process is also reflected by the progressive shortening of the incubation period in successive cotton rat passages, leading to eventual fixation of the virus.

Experiment II (March 30, 1942): The second experiment was carried out with the 116th mouse passage of Theiler's virus. The virus had been freshly prepared from an earlier glycerinated 115th mouse passage brain. The virus was carried in cotton rats through 11 serial intracerebral passages over a period of approximately 2 months. During this entire time the incubation period of the disease in cotton rats remained uniformly long, fluctuating within a range of from 4 to 7 days. Transfers from paralyzed cotton rats to mice (i.c. or i.p.), guinea pigs (i.c.) and rhesus monkeys (i.c.) were under-

TABLE 3

Transmission of Theiler's Mouse Virus (116th Passage) to Cotton Rats
Experiment II

Cotton Rat Passage	Date	Incubation Period	Pathogenicity for: Albino Mouse i.c.	Albino Mouse i.p.	Guinea Pig i.c.	Rhesus Monkey i.c.
I	3–30–42	5 days	10^{-5}	10^{-1}	3 negative	1 negative
II	4–4–42	4 days				
III	4–8–42	4–5 days	10^{-5}	10^{-1}	3 negative	1 negative
IV	4–13–42	4 days				
V	4–17–42	5 days	10^{-5}	10^{-1}	3 negative	1 negative
VI	4–22–42	6 days				
VII	4–29–42	5 days				
VIII	5–5–42	5–7 days				
IX	5–14–42	6 days				
X	5–20–42	5 days				
XI	5–29–42	7 days				

taken with the 1st, 3rd, and 5th cotton rat passages. The results obtained with these transfers are shown in Table 3.

It appears from Table 3 that the virus returned to mice from all three cotton rat passages tested with titers of 10^{-5} intracerebrally and 10^{-1} intraperitoneally; also, that virus from the same cotton rat passages produced no symptoms in guinea pigs or rhesus monkeys.

The results of this experiment were therefore at variance with those obtained in the first experiment in that Theiler's virus, after several cotton rat passages, failed to show any increased invasiveness for albino mice and proved to be wholly non-pathogenic for rhesus monkeys. In the absence of any good reasons which might explain the discrepancy it was decided to repeat the experiment with a mouse brain passage as close as possible to the one used in the first successful experiment.

Experiment III (May 29, 1942): The 110th mouse passage of Theiler's virus was used for the third experiment. The sample employed had been freshly prepared from the 109th glycerinated mouse passage. The virus was carried in cotton rats through 12 serial intracerebral passages over a period of about 7 months. The incubation period of the disease in cotton rats changed very abruptly from 4 days in the first passage to 2 days in the second passage and thereafter was maintained at the 2–3 day level throughout all subsequent transfers. Transfers from paralyzed cotton rats to albino mice (i.c. or i.p.) were carried out with the 1st, 2nd, 3rd, 5th, 6th, 7th, and 9th cotton rat passages; to guinea pigs (i.c.) with the 2nd, 3rd, 5th, and 9th cotton rat passages; and to rhesus monkeys (i.c. or i.v.) with the 2nd, 3rd, 5th, and 10th cotton rat passages. The results of these transfers are listed in Table 4.

It may be seen from Table 4 that the virus returned to mice from all cotton rat passages tested with marked intraperitoneal potency (10^{-8} to 10^{-4}), intracerebral titers being slightly above normal limits (10^{-9} to 10^{-6}). Injection of guinea pigs with early cotton rat virus produced paralysis irregularly but transfer from the 9th cotton rat passage proved capable of paralyzing all injected guinea pigs. Transfers to rhesus monkeys from either early or late cotton rat passages were followed by no symptoms in four monkeys, but caused an encephalitic syndrome in two monkeys and bulbar paralysis in one monkey; the latter animal had received a large dose of cotton rat virus by the intravenous route, whereas all other monkeys had been injected intracerebrally with small doses of virus. The disease could not

TABLE 4

Transmission of Theiler's Mouse Virus (110th Passage) to Cotton Rats
Experiment III

Cotton Rat Passage	Date	Incubation Period	Pathogenicity for Albino Mouse i.c.	Albino Mouse i.p.	Guinea Pig i.c.	Rhesus Monkey i.c.
I	5–29–42	4 days	10^{-0}	10^{-5}		
II	6–2–42	2 days	10^{-0}	10^{-6}	1 paralyzed 1 negative	1 encephalitis (AL 98) 1 negative
III	6–8–42	2 days	10^{-0}	10^{-0}	3 paralyzed	1 encephalitis (AM 1) 1 negative
IV	6–11–42	3 days				
V	6–15–42	2 days	10^{-0}	10^{-0}	1 paralyzed 3 negative	2 negative
VI	6–18–42	3 days	10^{-6}	10^{-4}		
VII	7–27–42	2 days	10^{-6}	10^{-5}		
VIII	8–11–42	2 days				
IX	9–8–42	2 days	10^{-6}		5 paralyzed	
X	10–16–42	2 days				1 bulbar paralysis (AM 45) after intravenous injection of virus
XI	11–10–42	3 days				
XII	12–10–42	2 days				

be further transmitted from monkey to monkey, but the virus returned readily to mice.

The results obtained in this experiment are in agreement with the observations made in the first experiment in that cotton rat passage had evidently brought about some change in Theiler's virus which served to enhance its peripheral infectivity for mice and enabled it to induce paralysis in guinea pigs as well as encephalitis or bulbar paralysis in rhesus monkeys. As compared with the first successful experiment, the adaptation in this experiment was of an explosive character, leading to a more rapid fixation of the virus in cotton rats and to an earlier development of pathogenicity for guinea pigs and rhesus monkeys.

In view of the diverging results obtained in three different experiments it seemed advisable to repeat the transmission of Theiler's virus from mice to cotton rats once more with another mouse brain passage.

Experiment IV (July 9, 1942): The passage closest to the 109th and 110th which was available was the 113th serial mouse transfer. A fresh 114th passage was prepared from the glycerinated brain and used for the fourth experiment. The virus was carried in cotton rats through 6 serial intracerebral passages over a period of about 5 months. The incubation period of the disease in cotton rats was uniformly long throughout the entire period, fluctuating between 8 and 5 days. Transfers from paralyzed cotton rats to albino mice were carried out with the 1st, 2nd, and 5th cotton rat passages. The results obtained with these transfers are given in Table 5.

It will be noted from Table 5 that the virus returned to mice from all cotton rat passages tested with exceptionally low potency, i.e., intracerebral titers reached only 10^{-3} and the virus failed to infect mice intraperitoneally with doses as large as 10^{-1}. The negative results of this experiment compare with those obtained in the second experiment in that Theiler's mouse virus, after passage through cotton rats, gave no evidence whatsoever of having acquired any enhanced infectivity for albino mice.

In summarizing the data available from four different experiments in which

TABLE 5

Transmission of Theiler's Mouse Virus (114th Passage) to Cotton Rats
Experiment IV

Cotton Rat Passage	Date	Incubation Period	Pathogenicity for Albino Mouse	
			i.c.	i.p.
I	7–9–42	7–8 days	10^{-3}	—
II	7–17–42	7–8 days	10^{-3}	—
III	7–31–42	5 days		
IV	8–11–42	6 days		
V	8–21–42	6 days	10^{-3}	
VI	11–12–42	6 days		

various mouse passages of the GDVII strain of Theiler's virus were transmitted from mice to cotton rats, with subsequent serial sub-passage through cotton rats, it appears that on two occasions (109, 110 lines) the virus became fixed in the new host and, coincidental with such fixation, had acquired new biological properties. These were reflected (a) by an enhanced peripheral infectivity for albino mice, and (b) by the ability to induce various types and degrees of central nervous system infection in guinea pigs and in rhesus monkeys. A detailed description of the clinical symptoms and pathological findings in these monkeys will be found at the end of this paper. Whatever viral changes had occurred were evidently of a permanent nature since continued subpassage of these cotton rat viruses in albino mice (10 serial mouse passages for the 109 line and 4 serial mouse passages for the 110 line of cotton rat virus) did not depress their enhanced intraperitoneal titer for albino mice. It is equally clear, however, that on two other occasions (116, 114 lines) the virus was not appreciably affected in its biological properties after having been subjected to a series of cotton rat passages.

The reasons for this discrepancy are unknown. It is conceivable that factors connected with the nature of the seed, or the receptivity of the cotton rat, or the cycle of the season spell the difference between success and failure, but our observations offer no tangible information on any of these points. The possibility must finally be considered that the virus recovered from paralyzed cotton rats may have been a contaminating virus, derived either from a latent virus carried by the cotton rats themselves, or introduced through inadvertent infection of cotton rats with a similar virus propagated in this laboratory. The first of these two alternatives seems hardly plausible. To begin with, Theiler's cotton rat virus (110 line) was highly infectious for cotton rats not only by the intracerebral route but paralyzed these animals also by intraperitoneal injection in dilutions up to 10^{-7} after an incubation period of 3 days. Moreover, a series of 9 successive cotton rat passages, initiated by the intracerebral injection of heat-inactivated Theiler mouse virus and propagated serially with the brains of symptomless cotton rats, sacrificed at 5 day intervals, failed to reveal the presence of any paralyzing agent through the entire period. The second alternative cannot be lightly dismissed inasmuch as Theiler's cotton rat virus possesses certain properties in common with the murine SK strain of poliomyelitis virus previously described from this laboratory. It therefore seemed of interest to transmit SK murine virus from mice to cotton rats and maintain serial cotton rat passages for several generations, with the object of comparing the course of the infection and the nature of SK cotton rat virus with similar data

pertaining to Theiler's cotton rat virus.

Experiment V (April 23, 1942): The 273rd serial mouse passage of SK murine virus was used for this experiment. The virus was carried in cotton rats through 8 serial intracerebral passages over a period of about 8 months. The incubation period of the disease in cotton rats, beginning with the first passage, was uniformly short (2 days) and remained pegged at this level throughout the entire experiment. In spite of high intracerebral potency, SK cotton rat passage virus displayed only moderate peripheral invasiveness for cotton rats, as indicated by an intraperitoneal titer of 10^{-3}. Transfers from paralyzed cotton rats to mice were carried out with the 1st, 2nd, 3rd, and 6th cotton rat passages; to rhesus monkeys with the 1st cotton rat passage. The results of this experiment are brought together in Table 6.

As may be seen from Table 6, the virus returned to mice from all cotton rat passages tested with uniformly high intracerebral (10^{-7}) and intraperitoneal (10^{-6}) titers and caused transient fever, but no other symptoms, in the two monkeys injected with virus from the first passage.

A comparison of the results obtained with Theiler's cotton rat virus (lines 109 and 110) and with SK cotton rat virus brings out certain similarities and dissimilarities between the two disease agents. Both viruses were indistinguishable with reference to their high intracerebral and intraperitoneal potency for albino mice and both were pathogenic for rhesus monkeys to various extent. They differed, however, in at least two significant respects. Thus, the transfer of Theiler's virus from mice to cotton rats assumed the pattern of an adaptive process which led to a gradual shortening of the incubation period in successive cotton rat passages, with eventual fixation of the virus; on the other hand, the transfer of SK virus from mice to cotton rats proceeded with a minimum incubation period from the first to the last passage, giving no evidence that the virus had undergone any form of adaptation. Moreover, fixed cotton rat Theiler virus was considerably more invasive for cotton rats peripherally (i.p. titer 10^{-7}) than was fixed cotton rat SK virus (i.p. titer 10^{-3}).

TABLE 6

Transmission of SK Murine Virus (273rd Passage) to Cotton Rats
Experiment V

Cotton Rat Passage	*Date*	*Incubation Period*	*Pathogenicity for*		
			Albino Mouse		*Rhesus Monkey*
			i.c.	*i.p.*	*i.c.*
I	4–23–42	1–2 days	10^{-7}	10^{-6}	2 fever
II	7–7–42	2 days	10^{-7}	10^{-6}	
III	7–9–42	2 days	10^{-7}	10^{-5}	
IV	7–29–42	2 days			
V	8–11–42	2 days			
VI	10–13–42	2 days		10^{-6}	
VII	11–10–42	2–3 days			
VIII	12–14–42	2 days			

The above data, while demonstrating some fundamental differences between Theiler cotton rat virus and SK cotton rat virus, are admittedly insufficient to permit of clear distinction between the two disease agents. It therefore became necessary to resort to cross-protection and cross-serological tests in order to provide the basis for a sharper differentiation of the two viruses on immunological grounds.

II. CROSS-PROTECTION TESTS BETWEEN THEILER'S MOUSE VIRUS, THEILER'S COTTON RAT VIRUS, AND SK COTTON RAT VIRUS

It is well known that mice which have passed through previous infection with Theiler's mouse virus, even though developing no symptoms, nevertheless acquire a relatively high degree of resistance against subsequent reinfection with the same virus. It was therefore thought that this fact might form a convenient basis for a screening test useful in separating individual virus entities belonging to a group of generally related viruses. Accordingly, an experiment was planned in which mice were actively immunized against Theiler's mouse virus and then reinfected with the three apparently similar viruses on hand, i.e., SK cotton rat virus and the two highly pathogenic strains of Theiler cotton rat virus (109 and 110 lines).

A group of 150 young mice, over a period of 2 weeks, received three doses of 0.1 ml. each of 10 per cent Theiler mouse virus by the intraperitoneal route. After an interval of 1 week, dating from the last injection, there were available for further tests a total of 95 mice (55 mice having died with paralysis during the course of immunization). The surviving mice were subdivided into three groups and reinfected intraperitoneally with either SK cotton rat virus or with Theiler cotton rat virus (109 or 110 lines), doses ranging between 0.1 ml. 10^{-2} and 10^{-6}. At the same time an adequate number of normal control mice, of similar age as the immunized mice, were infected with the three viruses in the same dosage. The results are shown in Table 7.

TABLE 7

Reinfection of Mice Immune to Theiler's Mouse Virus with Theiler's Cotton Rat Virus or SK Cotton Rat Virus

	Reinfection				*Controls*			
Immunized Mice	*Virus*	*Dose i.p.*	*Paralysis*	*Per cent*	*Virus*	*Dose i.p.*	*Paralysis*	*Per cent*
Immunized with Theiler's mouse virus	Theiler's cotton rat virus (109th line)	10^{-2}—10^{-6}	35/39	90	Theiler's cotton rat virus (109th line)	10^{-2}—10^{-6}	35/39	90
	Theiler's cotton rat virus (110th line)	10^{-2}—10^{-6}	16/29	55	Theiler's cotton rat virus (110th line)	10^{-2}—10^{-6}	31/31	100
	SK cotton rat virus	10^{-2}—10^{-6}	26/27	96	SK cotton rat virus	10^{-2}—10^{-6}	40/40	100

Numerator = number of mice paralyzed
Denominator = number of mice used

As will be seen from Table 7, mice immune to Theiler mouse virus had remained fully susceptible to subsequent inoculation with either SK cotton rat virus or one strain of Theiler cotton rat virus (109 line); on the other hand, the incidence of paralysis following reinfection with the other strain of Theiler cotton rat virus (110 line) was approximately half of that occurring in corresponding normal control mice. The foregoing experiment therefore offers suggestive evidence that at least one of the two highly pathogenic strains of Theiler cotton rat virus was antigenically more closely related to Theiler's mouse virus than was SK cotton rat virus. But since the data fell short of providing a decisive answer to the problem under discussion it became imperative to carry out detailed cross-neutralization tests with the various viruses and their corresponding antisera.

III. CROSS-NEUTRALIZATION TESTS BETWEEN THEILER'S MOUSE AND COTTON RAT VIRUSES AND SK MOUSE AND COTTON RAT VIRUSES BY THEIR CORRESPONDING ANTISERA

The principle of cross-neutralization was employed in these tests in an effort

to utilize the serological reactivity of certain critical virus-antiserum combinations as a method for determining the nature of the highly pathogenic strains of Theiler's virus obtained by passage through cotton rats. It seemed reasonable to assume that such cotton rat virus should be neutralized by antiserum against Theiler's mouse virus and that some neutralization would likewise be demonstrable between Theiler's mouse virus and an antiserum against Theiler's cotton rat virus. Conversely, it might be taken for granted that SK cotton rat virus would show neutralization with an antiserum against SK mouse virus and that SK mouse virus, in turn, would be neutralized by antiserum against SK cotton rat virus. It is also clear, on the other hand, that marked cross-reactions were not expected to occur between the two Theiler viruses and antisera prepared against the two SK viruses, or vice versa, provided the highly pathogenic strains of Theiler's cotton rat virus had been derived from Theiler's mouse virus and not from accidental contamination with SK virus.

All neutralization tests were carried out in young albino mice. The viruses were obtained from freshly harvested infected mouse brains. Antisera against the four viruses on hand (Theiler mouse virus, Theiler 110 cotton rat virus, SK mouse virus, SK 273 cotton rat virus) were produced by immunizing rabbits with slowly increasing doses of 5 to 10 per cent virus mouse brain emulsions, administered by both intravenous and intraperitoneal injection over a period

TABLE 8

Cross-Neutralization Tests with SK Mouse Virus, SK Cotton Rat Virus, Theiler Mouse Virus and Theiler Cotton Rat Virus and Their Corresponding Antisera

	Virus 10^{-1}							
Antisera	*SK Mouse*		*SK Cotton Rat*		*Theiler Mouse*		*Theiler Cotton Rat 110*	
SK mouse								
undiluted	0/6		0/6		7/9		0/6	
1:10	0/6		0/6		7/9		4/6	
1:100	0/6	3/24	0/6	5/24	6/9	25/36	6/6	16/24
1:500	0/3		3/3		5/9		3/3	
1:1000	3/3		2/3				3/3	
SK cotton rat								
undiluted	1/6		0/6		5/9		0/6	
1:10	1/6		0/6		7/9		3/6	
1:100	2/6	7/24	3/6	3/24	6/9	26/36	5/6	13/24
1:500	0/3		0/3		8/9		2/3	
1:1000	3/3		0/3				3/3	
Theiler mouse								
undiluted	0/6		1/6		0/9		0/6	
1:10	4/6		2/6		0/9		1/6	
1:100	6/6	16/24	6/6	15/24	0/9	4/36	3/6	8/24
1:500	3/3		3/3		4/9		2/3	
1:1000	3/3		3/3				2/3	
Theiler cotton rat								
undiluted	0/6		0/6		0/9		0/6	
1:10	4/6		1/6		0/9		0/6	
1:100	6/6	16/24	2/6	9/24	0/9	0/36	0/6	3/24
1:500	3/3		3/3		0/9		0/3	
1:1000	3/3		3/3				3/3	
Normal rabbit serum								
undiluted	9/9		9/9		7/9		9/9	
1:10	3/3		3/3		7/9		3/3	
1:100	3/3	21/21	3/3	21/21	7/9	29/36	3/3	21/21
1:500	3/3		3/3		8/9		3/3	
1:1000	3/3		3/3				3/3	

Technic: Antiserum and virus (SK mouse, SK cotton rat, Theiler cotton rat) were combined in amounts of 0.1 ml. each and the mixture, after incubation for 1 hour at 37° C. was injected intraperitoneally in a volume of 0.2 ml. In case of Theiler's mouse virus, 0.2 ml. of virus and 0.2 ml. of antiserum were used and the mixture was injected in a volume of 0.4 ml.

Numerator = number of mice paralyzed
Denominator = number of mice injected

of 1 month. Final bleedings were collected after a rest period of 1 week. Antisera, in various dilutions, were combined with a constant amount of virus; the mixtures were incubated for 1 hour at 37° C. and then injected intraperitoneally, in a volume of 0.2 ml. or 0.4 ml. each, into several mice. This method was chosen since preliminary tests had demonstrated that little or no neutralization was obtainable with any of these viruses and their corresponding antisera upon intracerebral injection. Normal rabbit serum was used for control purposes. The results are shown in Table 8.

The data presented in Table 8, barring some minor irregularities, are sufficiently clear and comprehensive to permit of unequivocal interpretation. It will be observed that each monovalent antiserum, in high dilutions, neutralized not only its specific virus but was also capable of inactivating its correspondingly related virus at similar levels of dilution. On the other hand, little or no cross-reactions occurred between these antisera and unrelated viruses, except with low dilutions of serum when overlapping was almost universal. For example, SK mouse virus antiserum neutralized SK mouse virus or SK cotton rat virus at titers of 1:500 or 1:100, respectively, whereas the same serum showed no neutralization or a neutralizing titer of only 1:1 with Theiler's mouse virus or with Theiler's cotton rat virus. Again, Theiler mouse virus antiserum neutralized Theiler's mouse virus or Theiler's cotton rat virus at titers of 1:500 or 1:100, respectively, while the same serum brought about neutralization of SK mouse virus or SK cotton rat virus at titers of only 1:1 or 1:10. Another approach is possible by examining the extent to which a given virus was neutralized by the various monovalent antisera. For example, SK mouse virus was neutralized by both, SK mouse virus antiserum or SK cotton rat virus antiserum, at a titer of 1:500 whereas Theiler mouse virus antiserum or Theiler cotton rat virus antiserum inactivated the same virus at a titer of only 1:1. Conversely, Theiler mouse virus was neutralized by both, Theiler mouse virus antiserum and Theiler cotton rat virus antiserum, at a titer of 1:500 while SK mouse virus antiserum or SK cotton rat virus antiserum showed no neutralization or a neutralizing titer of only 1:1 against the same virus.* Essentially similar results were obtained with an antiserum prepared by immunization with Theiler 109 cotton rat virus.

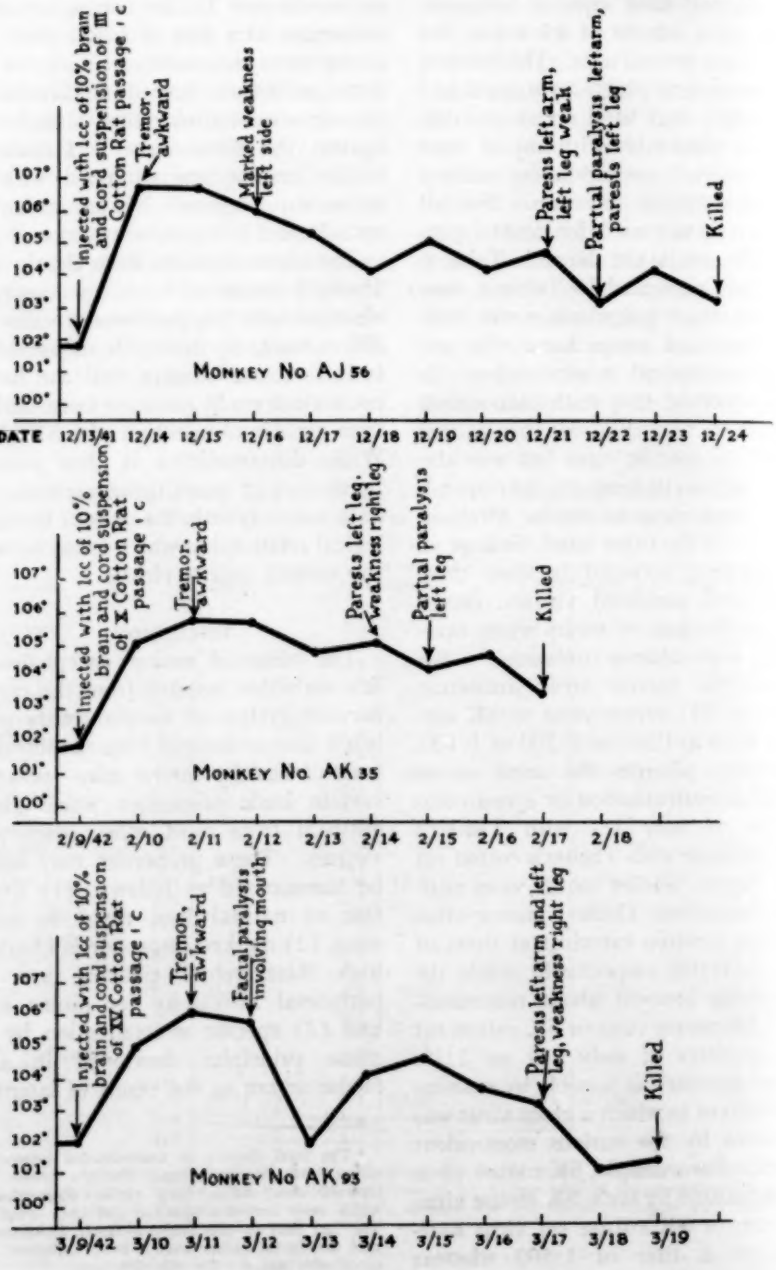
The above facts indicate clearly that Theiler's cotton rat virus is serologically identical with Theiler's mouse virus but differs markedly from SK mouse virus. It is therefore obvious that the cotton rat variant could not have been derived from accidental infection with SK virus. While differentiation is thus possible by the use of quantitative methods, the data also reveal the basic immunological relationship which exists between the various rodent viruses.

DISCUSSION

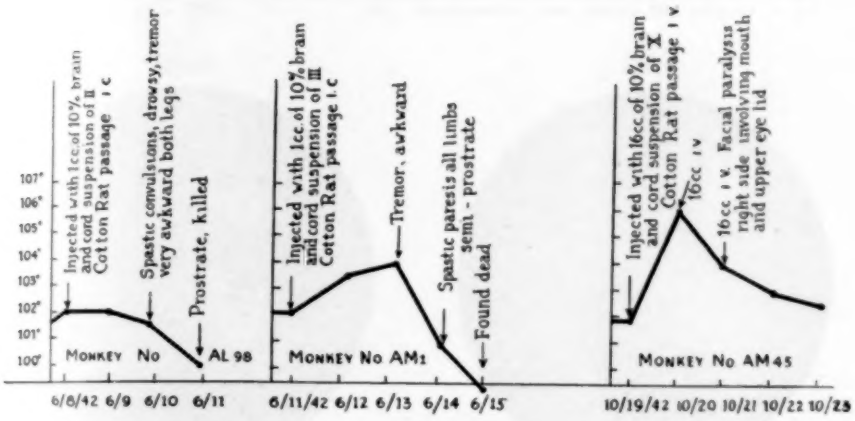
The virus of mouse encephalomyelitis—whether isolated from the central nervous system of spontaneously paralyzed mice or derived from the intestinal tract of healthy carrier mice—possesses certain basic properties which distinguish it from most other neurotropic viruses. These properties may briefly be summarized as follows: (1) limitation of natural host range to albino mice, (2) marked disproportion between high intracerebral potency and low peripheral infectivity for albino mice, and (3) specific neutralization by immune principles developed in adult mouse serum as the result of latent in-

* The total absence of neutralization between SK mouse virus antiserum and Theiler's mouse virus reported here differs from earlier observations in which some cross-neutralization had been described.[12] The fact that in this study a rabbit antiserum was used and in the earlier work a horse antiserum might conceivably account for this difference.

CLINICAL RECORD OF RHESUS MONKEYS WHICH DEVELOPED NERVOUS SYMPTOMS FOLLOWING INJECTIONS WITH THEILER'S COTTON RAT VIRUS (109th LINE)


Injected with 1cc of 10% brain and cord suspension of III Cotton Rat passage 1 c
Tremor, awkward
Marked weakness left side
Paresis left arm, left leg weak
Partial paralysis left arm, paresis left leg
Killed
MONKEY No AJ 56
DATE 12/13/41 12/14 12/15 12/16 12/17 12/18 12/19 12/20 12/21 12/22 12/23 12/24
Injected with 1cc of 10% brain and cord suspension of X Cotton Rat passage 1 c
Tremor, awkward
Paresis left leg, weakness right leg
Partial paralysis left leg
Killed
MONKEY No AK 35
2/9/42 2/10 2/11 2/12 2/13 2/14 2/15 2/16 2/17 2/18
Injected with 1cc of 10% brain and cord suspension of XV Cotton Rat passage 1 c
Tremor, awkward
Facial paralysis involving mouth
Paresis left arm and left leg, weakness right leg
Killed
MONKEY No AK 93
3/9/42 3/10 3/11 3/12 3/13 3/14 3/15 3/16 3/17 3/18 3/19
107° 106° 105° 104° 103° 102° 101° 100°

CLINICAL RECORD OF RHESUS MONKEYS WHICH DEVELOPED NERVOUS SYMPTOMS FOLLOWING INJECTION WITH THEILER'S COTTON RAT VIRUS (110th LINE)


Injected with 1cc of 10% brain and cord suspension of II Cotton Rat passage 1 c
Spastic convulsions, drowsy, tremor very awkward both legs
Prostrate, killed
107°
106°
105°
104°
103°
102°
101°
100°
MONKEY No AL 98
6/8/42 6/9 6/10 6/11
Injected with 1cc of 10% brain and cord suspension of III Cotton Rat passage 1 c
Tremor, awkward
Spastic paresis all limbs semi - prostrate
Found dead
MONKEY No AM1
6/11/42 6/12 6/13 6/14 6/15
Injected with 16cc of 10% brain and cord suspension of X Cotton Rat passage 1 v
16cc 1 v
16cc 1 v. Facial paralysis right side involving mouth and upper eye lid
MONKEY No AM45
10/19/42 10/20 10/21 10/22 10/23

fection. Taken together, these characteristics attest to the nearly perfect state of symbiosis which this virus has been able to achieve with its host in the course of time.

When mouse passage strains of Theiler's virus are tested in rodents free from this virus, they also fail to exhibit any *invasive* properties despite their high intracerebral potency. Thus, intraperitoneal injection of massive doses of the GDVII strain causes no paralysis in wild-caught cotton rats even though the same animals discharged no virus with their feces and harbored no neutralizing antibodies in their serum. Interestingly enough, however, cotton rats like albino mice are also susceptible to symptomless infection with Theiler's virus by natural routes; for after prolonged laboratory contact with albino mice, Theiler's virus could readily be demonstrated in cotton rat feces. It would seem, therefore, that the low grade character of the infection, which is pathognomonic of Theiler's disease in mice, is essentially due to the action of a degraded virus rather than to any restraining effect of herd immunity.

If it were feasible to propagate Theiler's virus systematically on virgin susceptible soil, an increase in virulence and invasiveness of the infectious agent might well be expected to occur. In other words, after serial passage through a proper intermediary host, Theiler's virus should show signs of an enhanced capacity to infect mice by peripheral routes; the gain in virulence might conceivably be sufficiently marked to permit the production of paralysis in other animal species normally refractory to the virus. It goes without saying that such newly acquired qualities could distort the familiar picture of the original virus almost beyond recognition. However, satisfactory evidence of the identity of the parent virus and its variant would be on hand provided the antigenic properties had been preserved during this process.

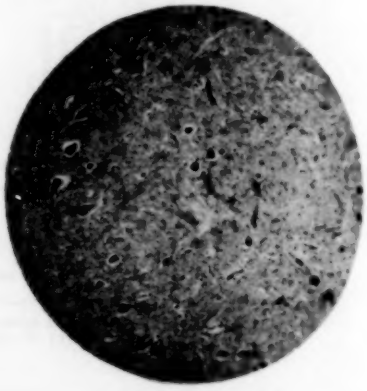
The data reported in this paper may be regarded as substantiating the hypothetical case outlined above. Thus, in

Pathological Record of Monkeys which Developed Symptoms of Central Nervous System Involvement following Injection with Theiler's Cotton Rat Virus (109th Line)

Monkey AJ56: Injected 12/13/41 with III cotton rat passage virus (109th line) sacrificed 12/24/41
Brain: No gross changes
Cord: Cervical level shows pinpoint hemorrhages, lumbar cord edematous
Fig. 1 Cervical cord showing unilateral lesion of anterior horn 46x
Fig. 2 Normal anterior horn 182x
Fig. 3 Destroyed anterior horn showing hemorrhages, perivascular infiltration and nerve cell necroses 182x
Fig. 4 Ganglion cell necrosis with neuronophagia 350x

No. 1

No. 2



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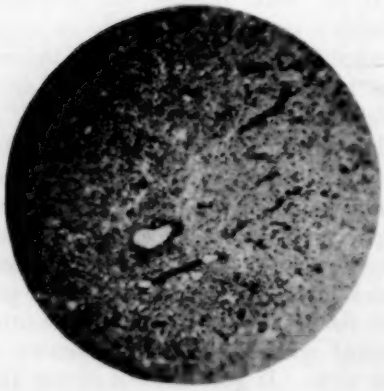
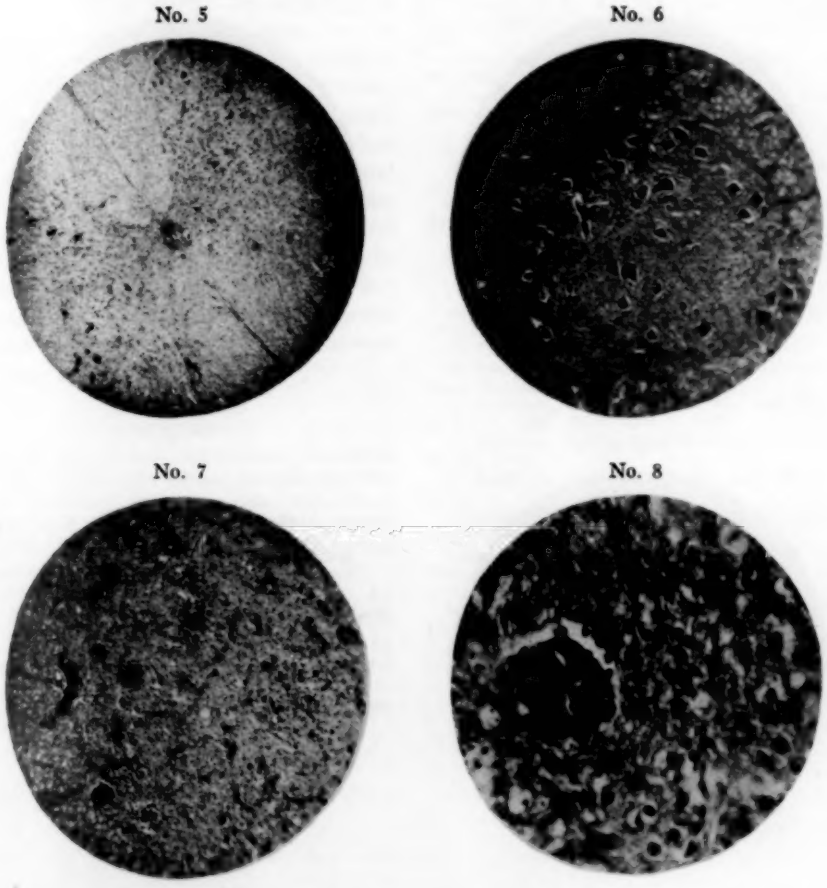


No. 4

two of four different experiments in which Theiler's virus was transmitted from mice to cotton rats, with subsequent serial subpassage in the latter animals, the virus became fixed in the new host and acquired new and enduring biological properties. To wit, the cotton rat strains showed greatly enhanced peripheral infectivity for albino mice and were capable of inducing various types and degrees of central nervous system involvement in guinea pigs and in rhesus monkeys. The lesions thus produced in monkeys are interesting for more than one reason. Their selective localization in either brain or cord illustrates the wide range of neurotropic affinity while their marked tendency for unilateral distribution reveals the limited invasive

Pathological Record of Monkeys which Developed Symptoms of Central Nervous System Involvement following Injection with Theiler's Cotton Rat Virus (109th Line)

Monkey AK35: Injected 2/9/42 with X cotton rat passage virus (109th line) sacrificed 2/17/42
Brain: No gross changes
Cord: Shows pinpoint hemorrhages and edema
Fig. 5 Lumbar cord showing unilateral lesion of anterior horn 46x
Fig. 6 Normal anterior horn 182x
Fig. 7 Destroyed anterior horn showing hemorrhages, perivascular infiltration and nerve cell necroses 182x
Fig. 8 Perivascular cuffing 350x



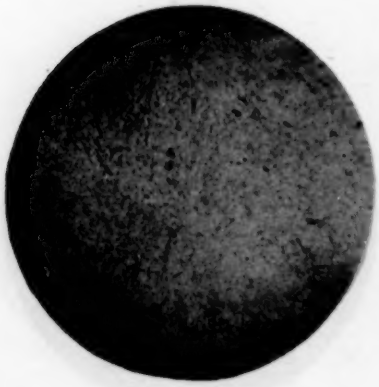
power of the virus in this host. Serological analysis in which Theiler's mouse virus and its cotton rat variant were subjected to cross-neutralization tests demonstrated clearly that the two strains were essentially identical in antigenic behavior. These tests also left no question that Theiler's cotton rat virus differed from SK cotton rat virus to the same extent as did Theiler's mouse virus from SK mouse virus. It may therefore safely be concluded that the observed transformation of Theiler's mouse virus was authentic, even if the key which controls this phenomenon is not yet at our disposal. A similar lack of regularity in results has been characteristic of all attempts to adapt human virus from monkeys to cotton rats and mice.

The process which led to these re-

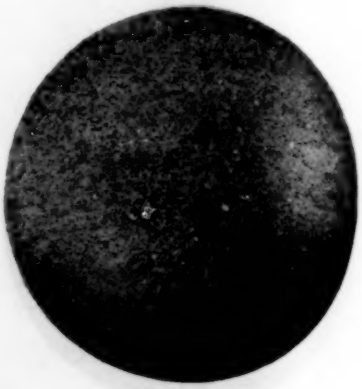
Pathological Record of Monkeys which Developed Symptoms of Central Nervous System Involvement following Injection with Theiler's Cotton Rat Virus (109th or 110th Line)

Monkey AK93: Injected 3/9/42 with XV cotton rat passage virus (109th line) sacrificed 3/19/42
Brain: Slightly congested
Cord: Edematous
Fig. 9 Normal tegmentum of pons (right side) 58x
Fig. 10 Focal lesion in tegmentum of pons (left side) 58x
Fig. 11 Infiltration by lymphocytes, microglial reaction, degeneration of nerve cells 182x

No. 9



No. 10



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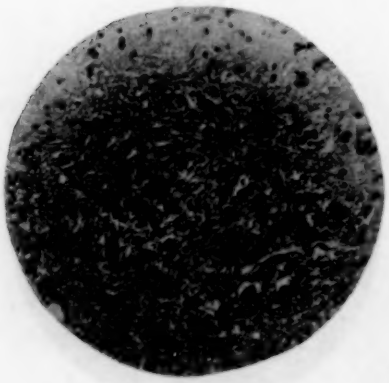

Monkey AL98: Injected 6/8/42 with II cotton rat passage virus (110th line) sacrificed 6/11/42
Brain: Congested
Cord: No gross changes

Monkey AM1: Injected 6/11/42 with III cotton rat passage virus (110th line) found dead 6/15/42
Brain: Marked hemorrhagic congestion
Cord: Pinpoint hemorrhages

Monkey AM45: Injected 10/19/42 with X cotton rat passage virus (110th line) sacrificed 10/23/43
Brain: No gross changes
Cord: No gross changes

markable changes of Theiler's virus had the earmarks of an induced variation. However, while the increase in virulence was permanent for rodents, it was only transient for monkeys, thus demonstrating the intrinsic incompleteness of viral adaptation. In its fundamental aspects, this variation is not unlike the R-S variation so well known from the study of dissociation phenomena among pathogenic bacteria. While the analogy can only be a superficial one, it is an attractive speculation to imagine that loss and gain of invasiveness in a virus may follow a relatively simple pattern, similar to what applies to the higher forms of microörganismal life.

The above mentioned facts form the nucleus of a broader biological concept which would rate the virus of human

poliomyelitis and the virus of mouse encephalomyelitis as descendants from a common primitive viral root. Because of extreme adaptation to man or mouse, both viruses have evidently emerged as essentially monopathogenic agents, incapable of producing disease in the natural host of the other. An exchange of pathogenicity, however, seems to be possible by passing these variants through a mutually susceptible environment. The term "poliomyelitis group" is therefore proposed as an appropriate designation for both the human and rodent strains. Placing these viruses together into such a system of natural classification not only does justice to their many striking similarities but opens the way for a better appreciation of the epidemiology of the human disease.

CONCLUSIONS

1. In two of four experiments, in which Theiler's virus of mouse encephalomyelitis was transmitted to cotton rats—with subsequent serial subpassage in the latter animals—the virus became fixed in the new host and acquired new biological properties.

2. These properties were reflected (a) by a marked increase in peripheral invasiveness for albino mice and cotton rats, and (b) by the ability to induce various types of central nervous system involvement in guinea pigs and in rhesus monkeys.

3. Evidence is adduced to show that the cotton rat variant was serologically identical with the parent virus.

REFERENCES

1. Theiler, M. *Science* 80:122, 1934
2. Olitsky, P. K. *Proc. Soc. Exper. Biol. & Med.*, 41:434, 1939; 43:296, 1940; *J. Exper. Med.*, 72:113, 1940.
Theiler, M., and Gard, S., *J. Exper. Med.*, 72:49, 79, 1940.
3. Loring, H. S., and Schwerdt, C. E. *J. Exper. Med.*, 75:395, 1943.
4. Bourdillon, J., and Moore, D. H. *Science*, 96: 541, 1942.
5. Gard, S., and Pedersen, K. O. *Science*, 94:493, 1941.
6. Lillie, R. D., and Armstrong, C. *Pub. Health Rep.*, 55: 115, 718, 1940.
7. Wolf, A. *J. Exper. Med.*, 76:53, 1942.
8. Olitsky, P. K., and Schlesinger, R. W. *Proc. Soc. Exper. Biol. & Med.*, 47:79, 1941.
9. Theiler, M. *J. Exper. Med.*, 65:705, 1937.
Olitsky, P. K. *Proc. Soc. Exper. Biol. & Med.*, 45:339, 1940.
10. Theiler, M. *Medicine*, 20:443, 1941.
11. Young, L. E., and Cumberland, M. C. *Am. J. Hyg.*, 37:216, 1943.
12. Jungeblut, C. W., Sanders, M., and Feiner, R. R. *J. Exper. Med.*, 75:611, 1942.
13. Jungeblut, C. W., and Dalldorf, G. *A.J.P.H.*, 33:169, 1943.
14. Armstrong, C. *Pub. Health Rep.*, 54:1719, 1939.
Jungeblut, C. W., and Sanders, M. *J. Exper. Med.*, 72:407, 1940.
Toomey, J. A., and Takacs, W. S. *Proc. Soc. Exper. Biol. & Med.*, 45:364, 1940; 46:22, 319, 1941; *J. Bact.*, 43:87, 1942.
Jungeblut, C. W., and Dalldorf, *A.J.P.H.*, 33:169, 1943.
15. Theiler, M., and Gard, S. *J. Exper. Med.*, 72:49, 1940.

The Etiology of Malignant Diphtheria

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THE clinical syndrome variously known as malignant diphtheria, hypertoxic diphtheria, and diphtheria gravis or grave diphtheria, may have been known, although under other names, for centuries. Descriptions are found in the writing of Hippocrates and in medical works of the 2nd century A.D., and elsewhere, which depict conditions agreeing more or less exactly with the modern definition of the disease. As distinguished today, malignant diphtheria is characterized usually by sudden and severe onset, with vomiting, high fever, and cardiac failure. Cervical adenopathy is marked, giving the "bull neck" commonly associated with the disease. Oral fetor and sanguinous nasal discharge are frequent, as is alsó albuminuria. The tonsils are usually excessively swollen, but pseudomembrane formation may be slight. *Corynebacterium diphtheriae* can regularly be obtained from the pharynx or tonsils. Drowsiness and cyanosis develop rapidly, and in spite of early, frequent, and large doses of antitoxin, death often supervenes in from 24 to 72 hours after onset. Adults and older children are frequently attacked.

The prevalence of very severe or malignant diphtheria has apparently fluctuated greatly from time to time. We may infer from writings of the early 18th century that it was a common scourge, sometimes referred to as "morbus suffocans" or "angina maligna," widespread in Europe and America. In succeeding years, the disease became less of a plague and, in the United States today, the severity of diphtheria, as well as its morbidity and mortality, is much less than formerly. In modern times, outbreaks of the malignant disease have been of a localized nature and have not spread widely, although during the period 1925 to 1935 there was a widespread increase in malignant diphtheria in Germany and other European countries. The case fatality rate in Berlin rose from about 5 per cent to around 27 per cent between 1924 and 1927.[1, 2] A large outbreak was studied in Leeds, England, in 1929–1930 by Anderson, *et al.*[3] In this hemisphere a smaller epidemic of the same nature was observed in 1936 in Belair, Md., by the writer, in coöperation with physicians of the Maryland State Health Department. In 1941 a severe outbreak occurred in Halifax, N. S., and has been described by Morton,[4] Campbell,[5] and Wheeler and Morton.[6] Numerous similar occurrences have been described in various parts of the globe.

The striking clinical features of malignant diphtheria as contrasted with those of the so-called "ordinary," or relatively mild diphtheria, have stimulated many workers to investigate the types of diphtheria bacilli involved in the former, with the hope of finding cultural or other properties which would explain the severity of the malignant disease, and furnish some clue as to why antitoxin is so often ineffective in such cases. Other workers have made studies on the prevalence of malignant

diphtheria and the relation of certain specific types of bacilli to it. Due to variations in epidemiological and bacteriological technics in these studies, and because of failure to define terms clearly, an unfortunate confusion has arisen between clinical and bacteriological terminology. It is one of the purposes of this paper to attempt some clarification of this situation.

Other aims of this discussion are to make additional suggestions concerning the etiology of malignant diphtheria and to present a summary of our present knowledge of the prevalence of the disease, and of *C. diphtheriae* of the so-called gravis type, in the United States.

I. CONFUSION BETWEEN CLINICAL AND BACTERIOLOGICAL TERMINOLOGY

Hammerschmidt,[7] in 1924, differentiated 3 main cultural types of *C. diphtheriae* in Germany, but his work has remained relatively obscure, possibly because he attached no clinical importance or names to the types of diphtheria bacilli described by him. In 1931, Anderson, *et al.*, at Leeds, England[3] described their now well known gravis and mitis types of diphtheria bacilli (the clinical implications inherent in these names being obvious), and indicated a causal relationship of *C. diphtheriae* gravis to malignant diphtheria.*

Confusion in terminology arose when attempts were made in various parts of the world to confirm the results of the Leeds workers. It appeared that, *for the time and place* of the studies, their clinical observations and laboratory observations, regarded as separate groups of data, were correct, i.e., the severe cases were characteristic of malignant diphtheria, and bacteriological descriptions were accurate. However, while the conclusions of the Leeds workers as to the causal relationship between malignant diphtheria and *C. diphtheriae* gravis received some confirmation,[8-14] many observers indicated that these conclusions were overgeneralized. For example, in other areas numerous strains *culturally* typical of the gravis type, were shown to be wholly avirulent as determined by the ordinary laboratory tests.[15] Outbreaks of diphtheria were seen in which the majority of severe and fatal cases, or many of them, were said not to be due to the gravis type of bacilli, but to strains having the cultural characters of the mitis or indeterminate types.[16-19] Patients with mild diphtheria, as well as healthy carriers, were found to harbor organisms indistinguishable from the gravis type of organism[15] and several workers found little, if any, significant relationship between cultural type of organism and clinical picture.[9, 20-25, 28-32] In addition, several workers had trouble in differentiating the cultural types of bacilli, or found them quite unstable and even interchangeable at will.[16, 26-29]

It is difficult to evaluate most of this work because only two or three writers described their types of *C. diphtheriae*

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* A rather close similarity may be noted between Hammerschmidt's group A and the mitis type of Anderson, *et al.*, and between the group C of the former and the gravis type of the latter. The differential characters used by each for distinguishing their principal groups or types were as follows:

Author	*Type or Group*	*Colony on Tellurite Agar*	*Hemolysis in Test Tube*	*Growth in Broth*	*Final Reaction in Broth* †	*Fermentation of*		*Pellicle formation*
						Starch	*Glycogen*	
Hammerschmidt	Group A	smooth	+	even turbidity	alkali			
Anderson, *et al.*	Mitis type	smooth	+	even turbidity	acid	—	—	—
Hammerschmidt	Group C	rough	—	granular	acid			
Anderson, *et al.*	Gravis type	rough	—	granular	alkali	+	+	+

† Most of Hammerschmidt's findings regarding types have been confirmed, but his results with regard to reaction in broth have not.

TABLE 1

Authors	*Criteria Used to Determine Gravis Types by Authors Cited*	*No. of Gravis Strains According to Varied Criteria among 237 Cultures of All Types*
Parish, Whatley, and O'Brien [22]	Starch fermentation, pellicle formation	19
Christison, Wright, and Shearer [26]	Starch fermentation, colony form	9
Dockeray [20]	Starch fermentation	43
Tannhil [17]	Starch, colony, pellicle	6 *
Mair [27]	Same as above	6 *
Schiff and Werber [13]	Starch, colony, pellicle, hemolysis	6 *
Carter [18]	Glycogen, starch, colony	6 †
Wright and Rankin [23]	Glycogen, starch, colony, morphology, hemolysis	6 †
Gregory [30]	Starch, colony	9
Anderson, *et al.*[3] (original Leeds workers)	Glycogen, starch, colony, morphology, pellicle, hemolysis, reversion of pH	4

* † The 6 strains in each group marked with an asterisk were the same, but were entirely different cultures from the 6 strains in the 2 groups marked with a dagger. Which are the true gravis strains?

in exactly the same terms. Many give no cultural details at all, and others are widely divergent in this respect, not only from each other but from the original, 1931, description as well. The difficulty is partly illustrated in Table 1. This table was prepared by applying the varied criteria used by several different writers for identifying gravis strains of diphtheria bacilli, to a group of 237 cultures studied by the author and his coworkers in Baltimore. All the significant characters of the latter cultures conformed to the original Leeds description and all had been determined in one laboratory. Obviously, the interpretations of many authors are open to question. In 1939, diphtheria in Leeds was restudied.[33] In the new study, however, a modified method of type determination was used, which is unfortunate in view of the confusion which had already arisen. The situation is not clarified by the recent review by one of the Leeds workers.[35]

The importance of uniform technic has previously been pointed out: "If reports upon the occurrence of gravis and mitis and intermediate types of *C. diphtheriae* in different parts of the world are to be comparable, the criteria of identification must be equivalent. The designations are not valid unless the strains under consideration have been shown to conform fairly closely to the criteria originally set up by Anderson, *et al*, as characteristic . . . Failure of many investigators to describe in detail the full complement of the biochemical characters of their 'gravis,' 'mitis,' and intermediate types, or the methods by which they were determined, or both, renders almost fruitless much of the work in the field." [34]

Because there has been such diversity of opinion as to the exact meaning of the terms *C. diphtheriae* gravis and *C. diphtheriae* mitis, it has been thought desirable to state clearly what is implied in our own use of these terms. In the present report, as in previous studies by the same author and his coworkers, strains of *C. diphtheriae* have been classed as mitis or gravis if, in addition to possessing the usual morphological and fermentative properties of *all* cul-

tures of *C. diphtheriae*, they have reacted as follows when tested by methods previously described.[34]

	Gravis	*Mitis*
Fermentation of starch	+	—
Fermentation of glycogen	+	—
Colony	rough	smooth
Hemolysis (broth)	—	+
Final pH in broth	7.5 or above	7.4 or below
Growth in broth	granular	even turbidity
Pellicle	+	—

These are the characters (except morphological details generally found to be of little differential value) originally described by the Leeds workers. In our usage, individual strains of either the mitis or gravis type *may or may not be virulent*, and they may come from any source. Cultures classed as gravis-like or mitis-like may be lacking in one or two of the more variable characters such as final pH, hemolysin production, or pellicle formation. Indeterminate strains are those which are not predominantly mitis-like or gravis-like in character. The so-called intermediate type is included by us with indeterminate strains. It might be stated also that, although some strains retain their gravis or mitis characters with some tenacity, in our hands many have changed greatly and are quite variable.

The definition given above, while in disagreement with some other writers, has the virtues of clarity and of agreement with the *original* description in point of cultural characters, if not in regard to virulence and source. *C. diphtheriae* gravis, as the term has been used by us, is thus clearly defined as a cultural variety without regard to any clinical or epidemiological significance. Additional reasons for thus divorcing biological properties from all clinical or epidemiological implications will be given farther on in this paper.

In addition to misunderstandings arising from misuse of bacteriological terms as just described, clinical ambiguity has arisen from use of the term "gravis diphtheria" or "diphtheria gravis" with inadequately defined meaning. One should state clearly whether, by gravis diphtheria, he means a case of diphtheria characterized by all (or only some) of the clinical features of the malignant disease, as set forth in a foregoing paragraph, without regard to the cultural type of diphtheria bacilli present, or whether, regardless of clinical features, he means a case from which a strain of *C. diphtheriae* culturally of the gravis type was isolated, or whether, on the other hand, a malignant case associated with bacilli having the cultural properties of *C. diphtheriae* gravis is meant. The question has also been raised whether the terms "gravis diphtheria" and *C. diphtheriae* gravis should not be restricted to cases and cultures occurring during *epidemics* of the malignant disease. This uncertainty further complicates both clinical and epidemiological discussion, to say nothing of perplexities arising from serious doubts, to be discussed presently, as to the ability of *C. diphtheriae* gravis, per se, to cause malignant diphtheria at all. These difficulties have not been very fully discussed by McLeod in his review of the present status of the gravis and other types of *C. diphtheriae*,[35] and seem to have been almost wholly unknown to the writer of a recent rather naive editorial on the subject.[36]

II. THE ETIOLOGY OF MALIGNANT DIPHTHERIA

1. Relationship of C. diphtheriae gravis to the disease—As noted above, serious objections have been raised against accepting *C. diphtheriae* gravis as the *sine qua non* of malignant diphtheria. Several experimental and other details are of special interest in this connection. For example, one of the salient features of malignant diphtheria is refractoriness to diphtheria antitoxin. This has been ascribed by some to a peculiarity of the exotoxin of *C.*

diphtheriae gravis. However, experimental investigations [14, 22, 25, 37] of this matter have shown conclusively that the exotoxins of all known types of *C. diphtheriae* are qualitatively identical. Zinnemann and Zinnemann,[14] reporting a series of investigations on the use of commercial toxoid and antitoxin in the control of hypertoxic diphtheria stated that ". . . in work on guinea pigs the preparations in common use today are of value in controlling both infections with gravis strains, and gravis intoxications." This is in agreement with earlier findings of Parish, Whatley, and O'Brien.[22]

Curiously enough, experimental evidence also indicates that gravis strains of *C. diphtheriae* are often inefficient toxin producers in laboratory media. [38, 39, 40] Not only are they poor toxin producers under such circumstances but, as shown by studies conducted in this laboratory, many strains are completely atoxigenic as ordinarily tested. This was the case, for example, in 1938–1939 in Virginia, where 7 of 11 carrier cultures of the gravis or gravis-like types were avirulent, while in Alabama, 28 of 40 carrier cultures of the same variety were avirulent.[41] Although virulent gravis strains were common in the populations investigated, diphtheria morbidity was very low indeed and malignant diphtheria entirely absent so far as can be determined. Later studies showed that the presence of virulent gravis strains was not significantly associated with malignant diphtheria elsewhere in the United States at the time the studies were made.

Obviously, the mere presence alone of diphtheria bacilli which are culturally of the gravis type, at least *in the form in which they appear in laboratory cultures as at present prepared,* is not in itself sufficient to cause malignant or hypertoxic diphtheria, although the organisms appear to be associated with the disease in certain outbreaks. We are therefore led to the conclusion that malignant diphtheria is due to (a) some property of *C. diphtheriae* other than any of these demonstrated in the laboratory by methods currently in use, or (b) some wholly extrinsic agent or agents acting in combination with *C. diphtheriae,* or (c) variations in host resistance.

2. Factors possibly responsible for the malignancy of diphtheria—If we arrange the factors involved in the development of malignant diphtheria in their natural relationship to each other, we might formulate an equation somewhat as follows:

$$\frac{\text{Toxigenicity of } C.\ diphtheriae + X}{\text{Host resistance}} = \text{Malignant diphtheria}$$

Attention may first be directed toward factor "X." This represents various hypothetical elements in addition to the familiar exotoxin of *C. diphtheriae.* In attempting to solve the equation we may try various factors in the place of X.

A. Synergistic infecting agents—One of the factors which might replace "X" is an infective agent acting synergistically with *C. diphtheriae,* possibly more effectively (or more frequently) with the variety called gravis than with other varieties. In this connection, we may recall many observations published some decades ago in France and Germany, indicating that streptococci were suspected of contributing to the severity of diphtheria. However, in the absence of exact methods of identifying streptococci (the blood agar plate was introduced for this purpose by Schottmüller in 1903 [42] while what is now termed the beta type hemolytic streptococcus was clearly differentiated by Smith and Brown [43] only in 1915), we have no exact data, from the earlier period, concerning the true nature of streptococci supposed to be of pathological or epidemiological significance

in malignant diphtheritic conditions. However, several of these papers are of interest.

Barbier,[44] in 1891, recognized the existence of two clinical types of diphtheria, malignant and mild, and performed numerous experiments to discover the rôle of streptococci in the former. He concluded that streptococci (a) prepare the ground for *C. diphtheriae*, and (b) form an "association microbienne redoubtable" with this organism, resulting in a malignant infection.

Bernheim,[45, 46] like many modern clinicians, observed cases of malignant diphtheria in which early and adequate dosage with antitoxin was of no avail. He also was convinced, by his clinical observations and laboratory studies, that streptococci were the organisms responsible, with diphtheria bacilli, for causing malignant diphtheria. Roux and Martin[47] had expressed the same opinion a little while earlier. Several other workers of the same period, including Funck[48] and Hilpert,[49] were in agreement with these ideas on the basis of both clinical and experimental observations, although there was some diversity of views on the exact mechanisms by means of which the organisms acted jointly.

Later workers likewise recognized malignant, antitoxin-refractory diphtheria as a distinctive clinical entity and many, like their predecessors, believed streptococci to act synergistically with *C. diphtheriae* in such cases. Borman[50, 51] was one of these, contemporary with the 1931 Leeds report on gravis type bacilli. He cites many workers who, like himself, achieved laudable therapeusis with a serum ("symbioseserum") prepared by injecting animals with mixtures of streptococcal and diphtheritic antigens. Grabenhofer[52] also was impressed with the value of such treatment. Hopmann and Panhuysen[53] admitted the importance of streptococci in malignant diphtheria.

In this country, according to Goepp,[54] the chief cause of "difference in the virulence of diphtheria" is "the association of other pathogenic germs with the *Bacillus diphtheriae*, such as staphylococcus, streptococcus, pneumococcus, and *B. coli communis*. The most virulent cases are those in which streptococci are present." Park, Williams, and Krumwiede[55] cited two cases of antitoxin-refractory diphtheria in which there were "massive membranes of hemolytic streptococci . . . as well as diphtheria bacilli. Both cases developed a fatal streptococcus septicemia." These authors further state (p. 397) that ". . . when other pathogenic bacteria are associated with diphtheria bacilli they mutually assist one another in their attacks on the mucous membrane, the streptococci being particularly active in this respect, often opening the way for the invasion of the diphtheria bacillus into the deeper tissues or supplying needed conditions for the development of its toxin. As these septic infections due to the pyogenic cocci are in no way influenced by the diphtheria antitoxin, they frequently are the cause of the fatal termination." In malignant cases occurring at Belair, Md., and studied by the author, *the provisional clinical diagnosis in two had been septic sore throat or scarlet fever*, and large numbers of Lancefield group A,[56] actively fibrinolytic,[57] hemolytic streptococci were present. A similar case was recently (1943) observed * in the Johns Hopkins Hospital. Curiously, Lancefield group B streptococci were present, with a mitis type of *C. diphtheriae*. About 165,000 units of antitoxin had but little visible effect on the condition of the patient, who eventually recovered. Sulfathiazole therapy was insti-

* Courtesy of Dr. Russell A. Nelson, Associate in Preventive Medicine, The Johns Hopkins University.

tuted early in the course of treatment. Streptococci of group B were isolated from a child who came to autopsy in January, 1943, at Baltimore, following diphtheria with moderately developed clinical features of the malignant disease.* Mitis type diphtheria bacilli accompanied the streptococci. In other cases, of lesser malignancy, strongly fibrinolytic group A, C, and G streptococci have been found.

Cases of "hemorrhagic diphtheria" such as those described by Hannah [58] and by Frank and Hartmann [59] might represent diphtheritic infections combined with toxigenic group A streptococci in persons who, if tested, would have given positive reactions to both Dick and Schick toxins. However, the rôle of the erythrogenic toxin of streptococci, whose relationship to scarlet fever and septic sore throat has been admirably summarized by Maxcy,[60] remains to be determined for diphtheria. Degrees of malignancy in combined infections might depend on the antifibrinolysin or mouse-protective [61] titer of the patient's blood serum. The relation of streptococci to malignant diphtheria obviously needs additional investigation.

In further consideration of synergistic agents in general, attention may be directed to the possibilities implied in Shope's discovery of the dual (virus-bacterial) etiology of severe or malignant swine influenza,[62] and the probable synergistic or accessory rôle of bacteria *(Salmonella and Pasteurella)* in the virus disease hog cholera.[63] There is little to suggest the action of a virus in malignant diphtheria, but the possibility should not be overlooked.

B. Variations in C. diphtheriae—A second possible factor in the etiology of malignant diphtheria might be the occurrence of an alteration in strains of *C. diphtheriae* prevalent in a given area, such that they acquire a greatly enhanced pathogenicity. Direct evidence for such an occurrence among diphtheria bacilli, especially in nature, is lacking, although fluctuations in virulence of many other species of bacteria *in the laboratory* are matters of common knowledge. Indirect general evidence and theoretical support for the view that such changes may occur (in infective agents *other than C. diphtheriae)* in nature, are to be found in the publications of Frost,[64] Greenwood, Topley, *et al.*,[65] Webster,[66, 67] and others. The sudden acquisition of a capsule, or of a somatic constituent analogous to the Vi-antigen of *Eberthella typhosa,* through the mechanism of bacterial variation, might confer greater pathogenic powers. Either occurrence is a biological possibility, but neither capsules nor *distinctive* noxious somatic substances have ever been satisfactorily demonstrated in diphtheria bacilli isolated from cases of malignant diphtheria. However, they may disappear during artificial cultivation as at present practised.

C. Special toxic properties of C. diphtheriae gravis—A third possible value for the factor X might be derived from greater toxigenicity or from toxic substances other than the exotoxin ordinarily considered characteristic of *C. diphtheriae.* As previously stated, adequate studies have shown the exotoxin of *C. diphtheriae* gravis, whether the strains tested were derived from malignant cases or from carriers, to be qualitatively identical with the exotoxin of Park 8 strains commonly used for commercial toxin, toxoid, and antitoxin production. Further, it has been shown that many gravis strains (when not completely atoxigenic), whether case strains or carrier strains, are rather poor toxin producers under ordinary conditions of test.

* Courtesy of Dr. John E. Gregory and Mrs. Isabelle G. Schaub, Department of Pathology and Bacteriology, School of Medicine, The Johns Hopkins University.

However, Mueller [38] has presented data suggesting that previous views on toxin production by gravis diphtheria bacilli may require revision. His idea is based partly on the observation by Pappenheimer and Johnson [68] that minute, but nevertheless excessive, amounts of iron interfere with good toxin production by ordinary strains of *C. diphtheriae* in various media. Mueller obtained a rough approximation of the iron content of a bit of pseudomembrane from a single case of diphtheria due to gravis type bacilli and found it relatively large. He suggested that malignant diphtheria might be due to infections with strains of *C. diphtheriae* which, unlike other strains, are capable of producing toxin in undiminished amount in spite of the excess of iron in the membrane, and that this property might be characteristic especially of gravis type bacilli. Tests *in vitro* with a single gravis strain supported his suggestion. This interesting line of experimentation could profitably be extended to a more conclusive result.

Several authors have reported a greater invasive property in gravis strains of diphtheria bacilli (presumably culturally typical strains from cases of malignant diphtheria), but the evidence on this point is far from convincing. For example, Zinnemann and Zinnemann,[14] Robinson and Marshall,[9] and Clauberg and Plenge [69] and others reported finding these organisms more frequently in the internal organs of artificially infected animals and in persons dead of diphtheria than was the case with mitis strains, but their figures lack statistical significance. In a series of autopsies on human diphtheria victims, McLeod, *et al.*,[33] never found diphtheria bacilli in the spleens or livers, but gravis strains were more frequent in lung infections than others. It was stated that in the throat there is "marked penetration (by *C. diphtheriae* gravis) into the deeper tissues, while at the same time the surface reaction is less efficient." In the deeper tissues, exotoxin might be more readily and completely absorbed than from surface membranes. These authors suggest that the greater penetrating power (assumed) of the gravis type of organism "may very possibly be due to toxic elements of which we have not yet got sufficient knowledge." It is of interest to contrast this suggestion with the statement of Park, Williams, and Krumwiede, before cited, concerning the rôle of streptococci in facilitating the passage of diphtheria bacilli into the deeper tissues.

O'Meara [70, 71] concluded that the gravis type of *C. diphtheriae* produces a special toxic substance ("B substance") which acts somewhat like the spreading factor of Duran-Reynals,[71a] and also synergistically in combination with the usual exotoxin ("A substance"), the combination producing both greater extension of the toxin and also an enhanced effectiveness of the latter. McLean [72] has found "No evidence—of any association between diffusing factor or hyaluronidase and substance B postulated by O'Meara . . ." Curiously, the so-called B substance, although spoken of as "an integral part of the exotoxin," was not sought for and demonstrated by him in the usual toxic filtrate, but *in saline extracts of bacilli* grown on Loeffler's slants. The B substance is said to combine with the few B antibodies (hypothetical) which may by good fortune be present in ordinary commercial antitoxin, thus lowering its therapeutic effectiveness. On the basis that B substance is present in diphtheria toxin, has different combining properties from those of the A substance, and varies in amount in different toxins, the writer explains at one Ehrlich's phenomenon, antigenic inadequacy of some ordinary toxoids, failure of ordinary antitoxin, Danysz's phenomenon, and some other details.

Unfortunately, the rather indefinite experiments which form the basis for the main conclusions are not fully controlled and the tabulated data do not give strong support to the statements concerning them. Because this report is among the most recent ones, and because it received rather wide notice in this country,[73] attempts were made in this laboratory to duplicate O'Meara's results. The attempts failed completely. Details appear elsewhere.[74] Discordant results were also obtained by Povitsky, *et al.*[75] No confirmatory reports have come to our attention so far.

3. Alterations or defects in host resistance—Giving, finally, some attention to the denominator of the fraction discussed in a foregoing paragraph, we may first consider the possibility that cases of malignant diphtheria develop in persons with some defect, or temporary reduction, in resistance. Zinsser, Enders, and Fothergill[76] state that they "are inclined at the moment to regard it (malignant diphtheria) as a fulminating type of infection that may, in large part, be due to host factors in the sense of variation in susceptibility." Susceptibility might easily vary significantly for several reasons such as (a) an absence of adequate natural and artificial antigenic stimuli, (b) dietary deficiencies (especially vitamin C), (c) extreme fatigue such as might attend a prolonged military effort or winter naval maneuver followed by arrival at an infected port, and (d) congenital mechanisms. It is impossible to evaluate these factors with any satisfactory degree of accuracy. We merely append references to discussions by authors who show that many of these factors might affect host resistance against infectious disease in general, or against diphtheria in particular,[77–86a] (e) Atwater[90] suggested that antibacterial immunity might be an important factor in diphtheria, especially in children supposedly immune, who develop the disease. The present status of antibacterial immunity has been reviewed by Frobisher and Parsons.[91] The rôle of host resistance to group A streptococci as a possible synergistic agent in malignant diphtheria has received too little consideration.

By way of summary of the foregoing sections of this paper, we may say that the pathogenesis of malignant diphtheria remains obscure. Certain promising lines of investigation are indicated, especially the rôle of hemolytic streptococci in the disease, and the toxigenic properties of certain strains of *C. diphtheriae* in relation to the iron content of their environment. The rôle of antibacterial immunity also deserves further investigation.

III. DISTRIBUTION IN THE UNITED STATES OF DIPHTHERIA BACILLI HAVING THE CULTURAL PROPERTIES OF C. DIPHTHERIAE GRAVIS

Since the gravis type of *C. diphtheriae* has been so widely thought of as causing, or at least being closely associated with, malignant diphtheria, it is of interest to note the results of bacteriological surveys for diphtheria bacilli carried out in various places in the United States during the past decade. These have shown that carriers of gravis strains of *C. diphtheriae*, virulent or avirulent, were relatively uncommon in the country as a whole. In Baltimore, in studies made from 1933 to 1937, only 12 strains of gravis-like organisms (virulent and avirulent) were found among 237 cultures from cases, contacts, and carriers.[87] cultures from carriers in this city were often atoxigenic. Later surveys (1940) in the same area showed that little significant change had occurred in the interval. In New York City, the situation in 1940 closely paralleled that of the Baltimore area in the same year.[31]

More widespread sampling of the

diphtheria flora in the United States as a whole during 1939–1941 yielded similar results.[41] Of 178 cultures of *C. diphtheriae* obtained from various clinical cases (none malignant so far as is known), and the immediate contacts thereof, during the fall, winter, and spring months of 1939–1940 and 1940–1941, in areas scattered from coast to coast and from Minnesota to Mississippi, only about 1 in 12 (8.4 per cent) was an organism having all or most of the principal cultural properties of *C. diphtheriae* gravis. Among the other cultures, 134 (77.5 per cent) were of the mitis or mitis-like types and 25 (14.1 per cent) of indeterminate character. Gravis strains were equally in the minority in a collection of 181 cultures from normal carriers collected during the same period in Alabama, Baltimore, New York City, and Salt Lake City. Of these cultures, 13 (7.1 per cent) were gravis or gravis-like and only 147 (81.2 per cent) mitis-like.* The remaining 11.7 per cent were indeterminate. Of the whole collection of 452 cultures isolated from all sources during the 1939–1941 surveys (178 from cases and their contacts, 181 from carriers, and 93 from sources grouped as "unknown") only 38 (8.3 per cent) were gravis-like, while 361 (80.2 per cent) were mitis-like, both virulent and avirulent strains being included. If consideration be given also to indeterminate strains, the ratio of all non-gravis strains to gravis-like is about 12 to 1.

It will be noted that many cultures collected in these surveys have been referred to as gravis-*like* or mitis-*like*. These terms may be rather too inclusive. If the discussion be confined exclusively to those cultures having *all* of the specific characteristics of *C. diphtheriae* gravis as originally described, and to *virulent strains* only,* but including cultures from both "mild" and "sereve" cases and carriers, the ratio of all *non-gravis* to *virulent gravis* would increase to about 75 to 1.

DISCUSSION AND SUMMARY

A review is given of the origin of the names *C. diphtheriae* gravis and *C. diphtheriae* mitis and of the concept that the former organism is causally related to malignant (gravis) diphtheria. Confusion arising from the adoption of varied definitions and bacteriological technics in studying these organisms, and their clinical relationships, is described.

In view of this confusion, it is here suggested that the term gravis diphtheria (or diphtheria gravis or grave diphtheria) be abandoned forthwith in favor of the term malignant diphtheria. It would also seem logical that the names of *C. diphtheriae* gravis and *C. diphtheriae* mitis be discontinued, first, as binomials not in conformity with the *International Rules of Botanical Nomenclature* and second, as bearing clinical implications which are not supported by adequate data. However, convenience and usage may dictate their continuance.

The various cultural types of *C. diphtheriae* could conveniently be designated by Roman numerals. Schemes of this sort have been advocated before.[88] A simple system is that devised by the writer in 1938,[34] in which the gravis type is numbered VII, the mitis type O, and indeterminate and intermediate varieties from I to VI inclusive, depending on the number of "gravis" characters possessed by them. Source and virulence should be stated separately.

A discussion of the etiology of malignant diphtheria points out that the disease is only irregularly associated with

* In the areas surveyed, there were, on the average, about two to three times as many carriers of avirulent cultures as of virulent ones.

the so-called gravis type of organism and that, in the United States at least, during the past decade, many strains of the organism have been found to be wholly atoxigenic. Reasons are mentioned for suspecting that some unknown factor or factors, either within the organism itself (development of a capsule, for example) or extraneous to, but operating in conjunction with it (such as physiological characters of the host or certain strains of hemolytic streptococci, or both), may be of determining significance in malignant diphtheria.

A brief review of the prevalence and distribution, in various parts of the United States, of virulent and avirulent diphtheria bacilli having the cultural characters of the gravis, mitis, and indeterminate types is given. It is shown that the former type was of relatively infrequent occurrence in the country as a whole at the time the studies were made.

REFERENCES

1. Delcher, H., and Agulnik, F. Ueber gehäuftes Auftreten ungewöhnlich bosartiger Diphtherie. *Deutsche. Med. Wchnschr.*, 53:825, 1927.

2. Minett, J. (cited only). *Bull. gen. de therap.*, 180:158, 1928.

3. Anderson, J. S., Happold, F. C., McLeod, J. W., and Thompson, J. G. On the Existence of Two Types of Diphtheria Bacillus: *B. diphtheriae* gravis and *B. diphtheriae* mitis. *J. Path. & Bact.*, 342: 667, 1931.

4. Morton, A. R. The Diphtheria Epidemic in Halifax. *Canad. M. A. J.*, 45:171, 1941.

5. Campbell, P. S. Occurrence of Diphtheria in Halifax from October 1, 1940 to January 31, 1941; Interim Report to Dominion Council of Health. *Canad. M. A. J.*, 32:404, 1941.

6. Wheeler, S., and Morton, A. R. Epidemiological Observations in the Halifax Epidemic. *A.J.P.H.*, 32:947, 1942.

7. Hammerschmidt, J. Ueber Gruppenbildung bei den Diphtheriebazillen. *Centralbl. f. Bakt.*, 93:443, 1924.

8. Leete, H. M., McLeod, J. W., and Morrison, A. C. Diphtheria in Hull and Its Relation to Bacteriological Type. *Lancet*, II:1141, 1933.

9. Robinson, D. T., and Marshall, F. U. Investigation of the Gravis, Mitis and Intermediate Types of *C. diphtheriae* and Their Clinical Significance. *J. Path. & Bact.*, 38:73, 1934.

10. Anderson, P. M., Goldsworthy, N. E., and Ward, H. K. Some Observations on the Relation between Clinical Types of Diphtheria and Cultural Types of *C. diphtheriae*. *M. J. Australia*, 2:350, 1936.

11. Wilson, H., and Goldsworthy, N. E. Observations on Diphtheria and the Bacterial Types of *C. diphtheriae*. *M. J. Australia*, 2:509, 1938.

12. Schiff, F., and Werber, M. Ueber die 3 Typen des Diphtheriebazillus. *Deutsche Med. Wchnschr.*, 61: 259, 1935.

13. Shone, H. R., Tucker, J. R., Glass, V., and Wright, H. D. Diphtheria in Liverpool with Special Reference to Type Incidence and Severity. *J. Path. & Bact.*, 48:155, 1939.

14. Zinnemann, K., and Zinnemann, I. Incidence and Significance of the Types of Diphtheria Bacilli in the Ukraine. *J. Path. & Bact.*, 48:155, 1939.

15. Frobisher, M., Jr. Strains of *C. diphtheriae* in Various Parts of the United States. *A.J.P.H.*, 30 (March suppl.):28, 1940.

16. Murray, J. F. One-hundred Sixty-six Cases of Diphtheria Correlated with the 3 Types of *B. diphtheriae* Concerned. *J. Path. & Bact.*, 41:97, 1935.

17. Tannahill, R. W. The Incidence and Clinical Correlation of Types of *Corynebacterium diphtheriae* at Romford, Essex. *J. Hyg.*, 36:140, 1936.

18. Carter, H. S. An Analysis of 510 Strains of *Corynebacterium diphtheriae*. *J. Hyg.*, 33:542, 1933.

19. Carter, J. S. A Further Analysis of the Types of *Corynebacterium diphtheriae* Common to the Glasgow Area. *J. Hyg.*, 36:147, 1936.

20. Dockeray, G. C. Types of *B. diphtheriae*. *Lancet*, 224:1075, 1933.

21. Wright, J. Types of *C. diphtheriae* in Capetown. *Brit. M. J.*, 1:259, 1937.

22. Parish, H. J., Whatley, E. E., and O'Brien, R. A. *B. diphtheriae*, Gravis and Mitis. *Brit. M. J.*, 2:915, 1932.

23. Wright, H. A., and Rankin, A. L. K. Biological Types of Diphtheria Bacilli. *Lancet*, 2:884, 1932.

24. Wright, H. A., and Christison, M. H. Further Observations on the Types of *Corynebacterium diphtheriae*. *J. Path. & Bact.*, 41:447, 1935.

25. Menton, J., Cooper, T. V., Duke, F. W., and Fussell, W. H. The Different Types of *Corynebacterium diphtheriae*. *J. Hyg.*, 33:414, 1933.

26. Christison, M. H. The Stability of the Mitis, Intermediate, and Gravis Types of *B. diphtheriae*. *J. Path. & Bact.*, 37:243, 1933.

27. Mair, W. J. The Different Forms of *Corynebacterium diphtheriae* and Their Significance. *J. Path. & Bact.*, 42:635, 1936.

28. Menton, J. The Different Forms of *Corynebacterium diphtheriae*. *J. Path. & Bact.*, 35:651, 1932.

29. Grubb, T. J., and Shaughnessy, H. J. The Incidence and Clinical Significance of Various Types of the Diphtheria Bacillus in Illinois. *Illinois M. J.*, Nov., 1936.

30. Shapiro, S. L., and Rukevitch, M. V. Typing of *C. diphtheriae* in Connection with the Clinical Course of Diphtheria Infection. *Brit. M. J.*, 2:373, 1937.

31. Seligmann, E. Types of Diphtheria Bacilli in New York City in 1940. *Am. J. Hyg.*, 34 (Sect. B): 125, 1941.

32. Otto, H., and Mittag, G. Erscheinungsformen des diphtherie Bacillus und klinisches Bild der Diphtherie. *Klin. Wchnschr.*, 16:294, 1937.

33. McLeod, J. W., Orr, J. W., and Woodcock, H. E. de C. The Morbid Anatomy of Gravis, Intermedius and Mitis diphtheria. *J. Path. & Bact.*, 46:99, 1939.

34. Frobisher, M., Jr. Types of *Corynebacterium diphtheriae* in Baltimore, Md. *Am. J. Hyg.*, 28:13, 1936.

35. McLeod, J. W. The Types Mitis, Intermedius, and Gravis of *Corynebacterium diphtheriae*. *Bact. Rev.*, 7:1, 1943.

36. Editorial. Grave Diphtheria. *J.A.M.A.*, 122: 176, 1943.

37. Povitsky, O. R., Eisner, M., and Jackson, E. Effectiveness of Standard Diphtheria Antitoxin against

All Types of Diphtheria Infection. *J. Infect. Dis.*, 52:247, 1933.

38. Mueller, J. H. Toxin Production as Related to the Clinical Severity of Diphtheria. *J. Immunol.*, 42:353, 1941.

39. Mader, E. W., and Halpern, K. C. Toxin Production and Intracutaneous Virulence of Recently Isolated Diphtheria Cultures. *Tr. Roy. Soc. Canada*, 25 (Sec. 5; Biol. Sci.):153, 1931.

40. Happold, F. C. Toxin Production by *C. diphtheriae* Types: Mitis, Gravis, and Intermedius. *Proc. Soc. Exper. Biol. & Med.*, 43:412, 1940.

41. Frobisher, M., Jr. Properties of Strains of *Corynebacterium diphtheriae* Obtained from Various Parts of the United States. *A.J.P.H.*, 32:709, 1942.

42. Schottmüller, H. Die Artunterscheidung der für den Menschen pathogenen Streptokokken durch Blutagar. *München. med. Wchschr.*, 1:849, 1905.

43. Smith, T., and Brown, J. H. A Study of Streptococci Isolated from Certain Presumably Milk-borne Epidemics of Tonsillitis Occurring in Massachusetts in 1913 and 1914. *J. Med. Res.*, 31:455, 1915.

44. Barbier, H. De quelques associations microbiennes dans la diphtherie. *Arch. Med. Exp.*, 3:361, 1891.

45. Bernheim, J. Ueber die Rolle der Streptococcen bei der experimentellen Mischinfektion mit Diphtheriebazillen. *Arch. f. Hyg.*, 28:138, 1897.

46. Idem. Ueber Immunisierung von Versuchthieren gegen die Mischinfektion mit Diphtheriebazillen und Streptococcen. *Ibid.*, 33:35, 1898.

47. Roux, E., and Martin, L. Contribution a l'etudie de la diphtherie. *Ann. Inst. Pasteur*, 8:609, 1894.

48. Funck, D. Experimentelle Studien über die Frage der Mischinfektion bei Diphtherie. *Ztschr. f. Hyg.*, 17:465, 1894.

49. Hilpert, P. Ueber Wesen und Bedeutung der Mischinfektion bei Diphtherie und ihr Verhältnis zur Heilserumtherapie. *Deutsch. Arch. f. klin. Med.*, 59:248, 1897.

50. Bormann, F. V. Erfahrung mit Symbiosieserum. *Deutsch med. Wchnschr.*, No. 27, 1931.

51. Idem. Die septische Diphtherie und die Anwendung des Symbiosesserums bei ihr. *Arch. f. Kinderh.*, 94:241, 1931.

52. Grabenhofer, A. Erfahrungen mit Symbioseserum. *München. med. Wchnschr.*, 78:1144, 1931.

53. Hopmann, R., and Panhuysen, A. Erfahrungen ueber den Charakterwandel der Diphtherie und zur Frage der Mischinfektion. *München. med. Wchnschr.*, 78:1208, 1931.

54. Goepp, R. M. *Medical State Board Questions and Answers.* Saunders, 1938.

55. Park, W. H., Williams, A. W., and Krumwiede, C. *Pathogenic Microörganisms.* Lea and Febiger. 9th Ed., 1929, p. 385.

56. Lancefield, R. C. A Serological Differentiation of Human and Other Groups of Hemolytic Streptococci. *J. Exper. Med.*, 57:571, 1933.

57. Tillett, W. S. The Fibrinolytic Activity of Hemolytic Streptococci. *Bact. Rev.*, 2:161, 1938.

58. Hannah, B. Hemorrhagic Diphtheria. *Canad. Pub. Health J.*, 21:9, 1930.

59. Frank, E., and Hartmann, E. Maligne Diphtherie mit hemorrhagischer Diathese. *Ztschr. f. klin. Med.*, 119:460, 1932.

60. Maxcy, K. F. Changing Conceptions of Scarlet Fever. *Am. J. M. Sc.*, 196:454, 1938.

61. Diefendorf, H. W. A Method for Detecting in Human Serum Protective Bodies against Hemolytic Streptococci. *Proc. Soc. Exper. Biol. & Med.*, 48:56, 1941.

62. Shope, R. E. Swine Influenza. III. Filtration Experiments and Etiology. *J. Exper. Med.*, 54:373, 1931.

63. de Schweinitz, H., and Dorset, M. New Facts Concerning the Etiology of Hog Cholera. *20th Ann. Rep. U. S. Bur. Animal Industry, 1903*, p. 57. Washington, D. C.

64. Frost, W. H. Epidemiology. *Public Health-Preventive Medicine.* Thos. Nelson, 1927. p. 163.

65. Greenwood, M., Hill, A. B., Topley, W. C., and Wilson, J. Experimental Epidemiology. *Spec. Rep. Ser., No. 209, Med. Res. Council*, London, 1936.

66. Webster, L. T. Inherited and Acquired Factors in Resistance to Infection. *J. Exper. Med.*, 57:793 and 819, 1933.

67. Idem. Inborn Resistance to Infectious Disease. *Science*, 48:61, 1939.

68. Pappenheimer, A. M., Jr., and Johnson, S. J. Studies in Diphtheria Toxin Production. I. The Effect of Iron and Copper. *Brit. J. Exper. Path.*, 17:335, 1936. See also Mueller, J. H. The Influence of Iron on the Production of Diphtheria Toxin. *J. Immunol.*, 42:343, 1941.

69. Clauberg, K. W., and Plenge, K. Untersuchungen zur Pathogenese der diphtherie. *Klin. Wchnschr.*, 16:223, 1937.

70. O'Meara, R. A. A. *C. diphtheriae* and the Composition of Its Toxin in Relation to Severity of Diphtheria. *J. Path. & Bact.*, 51:317, 1940.

71. Idem. A New Concept of the Toxaemia of Diphtheria. *Lancet*, 240:205, 1940.

71a. Duran-Reynals, F. Tissue Permeability and the Spreading Factors in Infection. *Bact. Rev.*, 6:197, 1942.

72. McLean, D. "Substance B" of Diphtheria Toxin and Diffusing Factor. *Lancet*, 240:595, 1941.

73. Editorials. *J.A.M.A.*, 118:301 and 380, 1942.

74. Frobisher, M., Jr., and Mauss, E. A. Failure to Demonstrate Synergism between Diphtheria Toxin and Extracts of *C. diphtheriae* gravis. *Am. J. Hyg.*, 37:225, 1943.

75. Povitsky, Olga R. Personal communication, June, 1943.

76. Zinsser, H., Enders, J. F., and Fothergill, L. D. *Immunity. Principles and Application in Medicine and Public Health.* Macmillan, 1939, p. 547.

77. Robertson, E. C. The Vitamins and Resistance to Infection. *Medicine*, 13:123, 1934.

78. Jungeblut, C. W. Studies on the Inactivation of Diphtheria Toxin by Vitamin C (l-ascorbic acid). *J. Infect. Dis.*, 69:70, 1941.

79. Fraser, D. T., and Halpern, K. C. Serial Titrations of Diphtheria Antitoxin Following Toxoid. *Canad. Pub. Health J.*, 26:476, 1935.

80. Jensen, C. Active Immunization Against Diphtheria by the Combined Subcutaneous and Intranasal Method. *Proc. Roy. Soc. Med.*, 30:(Sect. of Epid and State Med.), 71, 1937.

81. Jones, F. G., and Moss, J. M. The Antitoxic Titers of Human Subjects Following Immunization with Combined Diphtheria and Tetanus Toxoids, Alum Precipitated. *J. Immunol.*, 33:173, 1937.

82. Bigler, J. A., and Werner, M. Active Immunization Against Tetanus and Diphtheria in Infants and Children. *J.A.M.A.*, 116:2355, 1941.

83. Volk, V. K., and Bunney, W. E. A Study of Diphtheria Immunization with Fluid Toxoid and Alum Precipitated Toxoid. *A.J.P.H.*, 30:42, 1940.

84. Black, J. B. A Comparative Study of Susceptibility to Diphtheria in White and Negro Races. *Am. J. Hyg.*, 19:734, 1934.

85. Hirzfeld, H., Hirzfeld, L., and Brokman, H. On the Susceptibility to Diphtheria (Schick Test Positive) with Reference to the Inheritance of Blood Groups. *J. Immunol.*, 9:571, 1924.

86. Stuart, C. A., Sawin, P. B., *et al.* Group Specific Agglutinins in Rabbit Serums for Human Cells. *J. Immunol.*, 31:25 and 31, 1936.

86a. Hill, A. B. The Inheritance of Resistance to

Bacterial Infection in Animal Species. *Spec. Rep. Ser. No. 196. Medical Research Council.* London, 1934.

87. Smith, M. R. Diphtheria Carrier Surveys in Baltimore, 1921–1940. Thesis, M. Sc., The Johns Hopkins University, 1940.

88. Christison, M. H., Wright, H. A., and Shearer, B. J. A Note on Diphtheria Carriers with Reference to Types of *C. diphtheriae*. *J. Path. & Bact.*, 42: 345, 1936.

89. Gregory, T. S. Some Observations on the Types of *Corynebacterium diphtheriae* found in Victoria, Australia. *J. Path. & Bact.*, 45:333, 1937.

90. Atwater, R. M. Epidemiological Studies on Diphtheria in Baltimore, 1920–1921. Thesis, Dr.P.H., The Johns Hopkins University, 1921.

91. Frobisher, M., Jr., and Parsons, E. I. Resistance Against Toxigenic *Corynebacterium diphtheriae* in Rabbits Following Injections of Nontoxigenic Diphtheria Bacilli. *Am. J. Hyg.*, 37:53, 1943.

Tropical Medicine Grants

For the 6 month period ending June 30, 1943, 12 grants amounting to $43,680 were made by the American Foundation for Tropical Medicine, Inc., to 11 North American medical schools, a scientific journal, and the Army Medical Museum, it was reported by Dr. Jean A. Curran, executive director, at a meeting of the Executive Committee of the Board of Trustees in New York City on July 23.

These grants, made possible by contributions and pledges for the current year of $66,600 by 21 American corporations, are being used to strengthen teaching and research programs in tropical medicine and parasitology at the various schools. The approved projects were selected by the medical committee among a number of applications.

Medical schools to receive grants during the period from April 1 to June 30 were: Cornell University Medical College, Duke University School of Medicine, University of Pennsylvania School of Medicine, and Stanford University Medical School. The *Journal of Parasitology* was also aided.

Schools of medicine to which grants were made available during the first quarter of 1943 were: New York University College of Medicine, Tufts College Medical School, Tulane University School of Medicine, University of Manitoba Faculty of Medicine, University of Nebraska College of Medicine, and Yale University School of Medicine.

Companies which have made contributions or formal pledges of support include: Abbott Laboratories; American Cyanamid Company; Ciba Pharmaceutical Products Corp.; Firestone Plantations Company; General Foods Corporation; Hoffmann-La Roche, Inc.; The Lambert Company; Lederle Laboratories; Eli Lilly and Company; Merck & Co., Inc.; National Carbon Company; Parke, Davis and Company; E. R. Squibb & Sons; The Texas Company; United Fruit Company; William R. Warner & Company; Winthrop Chemical Company; Winthrop Products, Inc.; and John Wyeth & Brother.

The Foundation acted as the administrative agency for a special grant from the John and Mary R. Markle Foundation.

Use of Modern Laboratory Aids in the Investigation of a Typhoid Fever Outbreak

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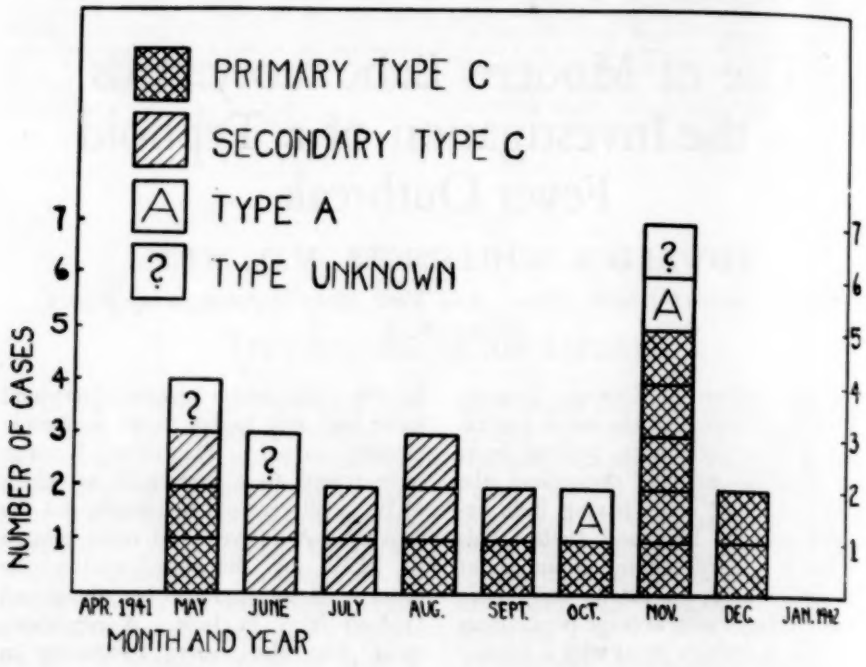
IN one section of Oswego County, which is located in the north central part of New York State, typhoid fever has remained endemic throughout the past decade, 27 cases having been reported between 1931 and 1940. This section is a dairy farming region about 80 square miles in extent and, aside from 3 villages with average populations of 1,250, is entirely rural with a density of approximately 30 persons per square mile.

As the months of 1941 passed, it became apparent that even for this region an unusual number of cases of the disease were occurring (Chart 1). By the end of the year, 25 cases of typhoid fever had been reported, 8 of these presumably secondary familial infections. All the cases developed outside the limits of the 3 incorporated villages. There was no selection as to sex among the primary cases, 9 being male and 8 female, and the age distribution of the cases was approximately that of the population at large.

The earlier part of the investigation disclosed the apparent sources of 4 of the 17 primary cases. The first case was that of a 7 year old girl who became ill in May after she had spent week-ends during the previous 2 months at the home of her grandmother, E.O. The grandmother, who prepared food for the child, had a history of typhoid fever and was found to be a chronic typhoid carrier. The other 3 cases were traced to a household in which M.W., a 59 year old housewife, did the cooking. A 51 year old man, related to M.W. by marriage, visited the latter's home before he developed typhoid fever in June. A neighbor's child, who also visited frequently in this home, became ill late in October. The third patient, the 2 year old granddaughter of M.W., fell ill a week after this. Although M.W. gave no history of typhoid fever, she did have recurrent attacks of colicky right upper quadrant pain and she was found to be a carrier.

Attempts to discover the source of infection in the remaining 13 primary cases proved fruitless at first. It was found that no single meal was eaten in common in more than 2 cases. Food served in the households of the cases was purchased from widely scattered sources. Milk and water used came from private supplies. In one restaurant patronized by 3 of the patients, fecal specimens submitted by the food handlers were negative for *Eberthella typhosa*. Blood sera from the food handlers revealed no Vi agglutination properties for *E. typhosa* when examined in the Division of Laboratories and Research of the New York State

CHART 1—Reported cases of typhoid fever in Oswego County according to months of onset and bacteriophage typing classified as primary and secondary familial cases



Department of Health by the method outlined by Coleman.[1]

In the circumstances it was important at this stage of the investigation to determine, by bacteriophage typing, the minimum number of foci of infection involved. With this in view, typing of all available cultures, according to the method of Craigie and Yen,[2] was begun late in November. Ten cultures were obtained from primary cases and 2 from secondary cases in households in which a strain could no longer be isolated from the original patient. Ten of these strains were found to be type C. Type A strains were isolated from 2 of the 3 cases traced to the carrier, M.W., whose strain was also found to be type A. No culture was available from the third case associated with this carrier. The other carrier, E.O., was also found to be type A, but no culture could be obtained from the case traced to her. In the ensuing 2 months, 2 more type C cases came to light. In another case discovered late in the course of the disease, the type was not determined because no typhoid organisms could be isolated.

The results of bacteriophage typing showed that the 2 type A carriers were not responsible for the major portion of the outbreak. The discovery of the type A cases, furthermore, confirmed the occurrence of a small outbreak unrelated to the larger mass of cases. Finally, the knowledge that at least 12 cases were type C made it likely that a single source of infection was responsible for the majority of the cases. The clue to this source was uncovered during the investigation of the last case developing in 1941.

F.E., an 18 year old boy, became ill with typhoid fever on December 18,

1941. Organisms isolated from this case belonged to type C. The boy had been employed in the preparation of mild American cheese at a small factory (hereinafter referred to simply as "the cheese factory") located at the fringe of the area in which the outbreak occurred. After questioning, it was learned that this patient had eaten curd several times at the cheese factory in the month before he became ill. He also stated that he had met several of the previous cases when they came to the cheese factory on business.

Reinvestigation of the other cases revealed that all but 2 of the primary type C cases, as well as the untyped case discovered during the course of the investigation, had eaten fresh curd obtained from the cheese factory during the 30 days prior to the onset of their disease. The 2 exceptions had had fresh cheese from the same source before they became ill. A typical story is that of R.M., a 22 year old dairy farmer. He had helped himself to curd from one of the vats on May 18, on one of the two occasions on which he delivered milk to the factory. He became ill about 8 days later. Taking the curd had been such a casual act that it had slipped his mind until he was questioned about it specifically. The only type C case without a definite history of having eaten curd or fresh cheese from the common source was a traveling salesman who died before this phase of the investigation was opened. This salesman, however, was known to have been fond of cheese and he had travelled through the area in which the outbreak occurred during the 6 weeks before the onset of his illness. Neither of the type A cases nor the third case stemming from the same type A carrier had taken any curd at all and none had any cheese that could be traced to the factory. The 11 surviving primary type C cases therefore definitely had curd or fresh cheese from the factory whereas the type A cases as definitely did not have any from the same source.

With this evidence pointing to the products of the cheese factory as the medium of infection, it became necessary to determine whether the method of preparation of the cheese was compatible with continued survival of *E. typhosa*. Analysis of the process of manufacture revealed that the temperature of the milk or cheese was never raised above 106° F., and the acidity of the curd and fresh cheese was not materially altered from that of the original milk. The milk was delivered into vats directly from the farmers' milk cans. Rennin was stirred into the milk after the latter had been heated to 86° F. The temperature of the resulting coagulum or curd was then raised further to 106° and maintained at this level for 30 minutes. The rubbery mass remaining was finally ground and salted and placed in wooden molds. On the following day the fresh cheese was removed from the molds and allowed to stand at room temperature for about 2 weeks before it was shipped to a large factory in a neighboring county. There pasteurized American process cheese emerged as the final product. This description of the process shows that continued survival and even some growth of *E. typhosa* was possible in the curd and fresh cheese until aging caused acidification of the cheese.[3]

Even though the possibility of transmission of *E. typhosa* through the cheese products was demonstrated, this did not eliminate a chance association between eating the curd or cheese and the development of typhoid fever in the type C cases. Curd was a popular food locally and was to be obtained from three other cheese factories in the neighborhood as well as from the cheese factory implicated in the investigation. Nevertheless, none of these other fac-

tories was mentioned by the type C cases as the source of any cheese or curd they consumed. A small survey of 10 households in the region selected at random showed that members of only one household had eaten curd from the suspected cheese factory during the month preceding the date of questioning, contrasting sharply with the history of the type C cases. These facts strengthened the case against the cheese factory.

As a rough estimate, an average of 5 persons obtained curd from the factory daily, making a minimum of 1,200 person-exposures to possible infection over a period of 8 months. Yet only 12 cases of typhoid fever, whose probable source was the cheese factory, were reported during this period. With extensive consumption of curd, the question might be posed as to why an epidemic of far greater proportions did not occur. The chain of infection from carrier to case is a tenuous one at best. It is probable that contamination of the curd took place intermittently. Furthermore, two batches of cheese were prepared separately each day in each of two vats, so that the chance of contaminated milk reaching any given batch was only 1 in 4. Finally, it was local household practice to "can" the curd; i.e., place it in airtight jars, for periods of 4 to 8 weeks, in order to mellow it. This reduced the danger of infection to a minimum. In regard to fresh cheese, very little of this was sold at the factory, almost the entire output of the factory going into the manufacture of American process cheese.

On the evidence at hand, the following restrictions were placed upon the cheese factory with the concurrence of the owner: The sale of curd and of fresh cheese less than 6 weeks of age was to be stopped. Strict orders were to be issued to the employees of the cheese factory forbidding the consumption of curd in the factory and prohibiting removal of any curd from the factory by employees or by others having business in the plant.

With these restrictions in force, a search was undertaken for a typhoid carrier in the factory. A series of 3 fecal specimens were examined from each of 9 of 10 persons employed in the factory at any time during 1941, as well as from the owner's wife and child who entered the factory almost daily. The 10th person, who could not be reached, was a 19 year old boy who had worked at the factory for only a few days. In addition, Vi antibody studies were performed on blood specimens obtained from the owner and the 2 steadily employed workers. The results of all these examinations were negative. A sanitary survey of the water supply serving the factory evidenced no permanent source of human pollution within dangerous distances. Bacteriological examination of the water showed no coliform organisms. It was felt that the supply should be of safe sanitary quality. In view of these negative findings, contamination of the curd at the factory was therefore extremely unlikely.

The search for a typhoid carrier among the dairy farmers supplying the cheese factory concluded the investigation. Review of the factory records revealed that 242 farmers had shipped milk to the factory at some time during the last 9 months of 1941. Of these, 64 had delivered milk regularly during the entire period. Prominent among these 64 was a 57 year old farm housewife, N.M., who had been under suspicion on a previous occasion as a possible typhoid carrier.

N.M., whose chores included milking the cows, first came under attention in 1935 when 7 persons on a neighboring farm developed typhoid fever. She had had typhoid in 1918, following which she had suffered for 6 months from attacks of epigastric pain radiating to

the right shoulder. The first fecal specimen obtained from her in 1935 revealed the presence of *E. typhosa*, but 9 subsequent specimens were negative. Milk from her farm was first delivered to the cheese factory in October and November, 1940. No further deliveries were made until April 1, 1941, 5 weeks before the onset of the first case traced to the cheese factory. Because of this epidemiological evidence, N.M. was strongly suspected as the source of the 1941 outbreak. A blood specimen secured early in 1942 showing the presence of Vi antibody in a titer of 1:80 further strengthened this suspicion. However, 18 fecal specimens submitted by her between February 17 and August 31, 1942, were negative for typhoid bacilli, despite the fact that 9 specimens were authenticated by the use of lycopodium spore capsules prior to submission of the specimens and liquid specimens were obtained by the administration of magnesium sulfate. Finally she was hospitalized. A series of 3 biliary and fecal specimens secured on successive days, each time following the injection of magnesium sulfate via duodenal tube, contained *E. typhosa*. The type of the organisms could not be determined with the bacteriophage preparations available but it was definitely not type C. Therefore, despite the overwhelming epidemiological evidence, N.M. was not the source of this outbreak. While N.M.'s status was being settled, 20 other dairy farmers were examined with negative results.

For the first 8 months of 1942, Oswego County was free of typhoid fever. In September, 2 new type C cases were reported. Both of these had secured curd from the factory during the month before the onset of their illness. Apparently the constant turnover in help at the factory had made it difficult for the owner to maintain the restrictions upon which he had agreed.

Another case of typhoid fever, occurring in one of the nearby villages in the month of September, 1942, led to the discovery of the carrier presumably responsible for the outbreak. This 30 year old patient, whose organisms were resistant to typing, had never eaten curd and he disliked cheese. However, he had spent 3 weeks on the farm of one of the 64 dairy farmers, G.W., 47 years of age, who had delivered milk to the cheese factory during the entire period of the outbreak. This visit to the farm had terminated 6 weeks before the onset of the patient's illness, but the patient had paid another short visit 3 weeks later. Five fecal specimens were submitted by the dairy farmer and all contained typhoid bacilli which fell into type C. G.W. had no history of typhoid fever and no complaints suggestive of cholecystic disease. The absence of a history of the ingestion by the carrier of any products of the cheese factory eliminated the possibility of a passive carrier state. Milk deliveries to the cheese factory from his farm had begun in May, 1940. No further cases of typhoid fever have been traced to the cheese factory since September, 1942, a period of 11 months at the time of writing. Milk deliveries to the cheese factory have been stopped from the farms of the 2 carriers.

DISCUSSION

Although a number of epidemics of typhoid fever due to contaminated cheese have been reported,[4, 5] the present outbreak has several features of unusual interest. In the first place, the main body of cases were spread over a period of 8 months, with 2 more cases 9 months later, indicating repeated contamination of the milk supply of the cheese factory. In the second place, the majority of the cases became infected by eating small amounts of curd at the factory, usually when they entered the factory on business. Although the curd was used extensively in the

neighborhood, very little of it was consumed in a fresh state away from the factory. Finally, 4 cases occurring contemporaneously with those caused by ingestion of cheese or curd were found to be unrelated to the latter.

The use of more recently developed laboratory procedures provided valuable assistance during the course of the investigation. Bacteriophage typing confirmed the existence of two components unrelated to the main outbreak. It ruled out the type A typhoid carriers as the cause of the outbreak and later, when 2 carriers were found among the dairy farmers supplying the cheese factory, typing definitely eliminated one of them as the ultimate source of the outbreak and indicated the probable responsibility of the other. The utilization of Vi antibody studies permitted a more certain exclusion of the food handlers in the restaurant and cheese factory as typhoid carriers. The presence of Vi antibody in the blood from N.M. encouraged continued search for typhoid bacilli in her fecal specimens, despite the fact that a total of 18 specimens, several authenticated by the use of lycopodium spores, were negative. The combined Vi antibody studies and bacteriophage typing relegated N.M. to her proper place as an incidental carrier unrelated to the causation of the outbreak.

SUMMARY AND CONCLUSIONS

1. An outbreak of 27 cases of typhoid fever is described, 23 of which were probably due to the ingestion of curd or fresh cheese at a local factory or were secondary to such cases. The cases occurred over a period of 17 months.

2. Bacteriophage typing separated the type C cases, due to the contaminated curd and cheese, from type A cases, traced to food prepared by 2 type A typhoid carriers.

3. Two typhoid carriers were found among the dairy farmers supplying the cheese factory. Typing showed one to be type C and eliminated the other as the possible source of the outbreak, despite the fact that epidemiological evidence alone pointed more forcefully to the latter as the carrier responsible for the outbreak.

REFERENCES

1. Coleman, M. B. Experience with the Test for Vi Agglutinative Properties for *Eberthella typhosa*. *A.J.P.H.*, 32:843–847, 1942.

2. Craigie, J., and Yen, C. H. The Demonstration of Types of *B. typhosus* by Means of Preparations of Type II Vi Phage. *Canad. Pub. Health J.*, 29:448–463, 1938; 29:484–491, 1938.

3. Wade, E. M., and Shere, L. Longevity of Typhoid Bacilli in Cheddar Cheese, a Study Following an Outbreak of Typhoid Fever Traced to Cheese. *A.J.P.H.*, 18:1480–1488, 1928.

4. Swanner, R. O. Cheese as a Source of Food Poisoning and a Conveyor of Pathogenic Bacteria. Unpublished report. New York State Department of Health, Albany, N. Y.

5. Bowman, M. An Epidemic of Typhoid Fever Due to Cheese. *Canad. Pub. Health J.*, 33:541–547, 1942.

NOTE: We wish to express our appreciation to the following members of the Staff of the New York State Department of Health: Dr. Edward B. Bukowski, Acting District State Health Officer, for his supervision and encouragement throughout the investigation and for his own investigation of the first case of typhoid fever to occur in 1941, resulting in the discovery of the typhoid carrier, E.O., as the source of the case; Marion B. Coleman of the Division of Laboratories and Research for the performance of the Vi antibody studies and bacteriophage typing, the results of which are given in the body of the paper; and Herbert H. Wagenhals, District Sanitary Engineer, for the sanitary survey of the water supply serving the cheese factory.

Epidemic Diarrhea of the New-born: A Report of Two Outbreaks

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TWO outbreaks of diarrhea of newborn infants occurred in a hospital in Rochester, N. Y., within a 4 month period. In the first outbreak the disease seemed to be transmitted chiefly by contaminated rubber nipples and formulae and to a lesser extent by indirect contact; in the second it was apparently transmitted by faulty maternal breast technic. Both outbreaks promptly came to an end following control measures based upon studies of the mode of transmission.

METHODS OF INVESTIGATION

The investigation was conducted by representatives of the Rochester Health Bureau and the New York State Department of Health, with the coöperation of the hospital staff. Data for all infants, sick and well, were transcribed from hospital records to epidemiological record forms upon which were entered name, address, date of birth, sex, color, nursery or nurseries occupied, outcome, and daily observations of weight, body temperature, feeding, stools, special procedures, and unusual occurrences. To provide a base-line of normalcy, these records were obtained for pre- and post-epidemic as well as the epidemic periods. The methods employed by the hospital for recognition of cases, isolation, general nursery technic, and formula preparation were studied in detail, and samples of feces and of nipples, bottles, and formula were subjected to bacteriological examination.

FIRST OUTBREAK: APRIL–MAY, 1942

An investigation was begun May 1, when through following up a death certificate it was discovered that a number of cases of diarrhea, some fatal, had occurred among infants in the hospital during the latter part of April.

Nature of the illness—Severe cases were characterized by frequent loose greenish stools, reddening of the buttocks, mild fever, dehydration, and loss of weight. This was the type of case generally conceded by hospital staff physicians to represent clear-cut diarrhea of the new-born. There were 28 such cases, in which group all of the 3 fatalities occurred. One death was of an infant with a cephalic deformity compatible with life, one in an infant with cerebral hemorrhage, and one in an infant born prematurely but of normal birth weight.

Twenty-two infants which presented signs and symptoms only slightly less marked were considered by the investigators to be definite cases also, making a total of 50 in this outbreak. Twelve others with still milder signs were classified as suspicious cases, and an additional 21 who showed only slight

deviations from normal, such as a few green stools or a temporary increase in number, were classified as probably normal. One hundred and thirty-five infants were considered to be normal. Thus, as in many other diseases, there was a gradation from normal to very severe which, in the absence of a means of laboratory confirmation, presented a very difficult problem in diagnosis.

Diagnosis—From the epidemiological standpoint it made little difference whether one diagnosed as epidemic diarrhea of the new-born only the 28 severe cases, or included the 22 definite but milder cases, since the distribution of the two types was similar with respect to date of onset, nursery of occurrence, feeding history, etc. From the standpoint of control, however, the diagnosis and segregation of the milder cases was of great importance since they also were presumably infectious. This may have been true of the suspicious cases as well. As an aid in diagnosis a rigid classification was set up and adhered to. The essence of it was that if an infant had more than one loose stool in one day he was considered as suspicious, and if loose stools persisted for two or more days he was classified as a case.

Chronology—Figure 1 shows the distribution of severe, mild, and suspicious cases according to date of onset. The probably normal infants are not shown because they present no chronological relationship to the epidemic and are considered to represent only simple biologic variations from the norm. The outbreak began about April 7 and ended May 8. A marked peak occurred on April 27 when 14 definite cases occurred. The distribution of suspicious cases does not follow closely the other two types except that

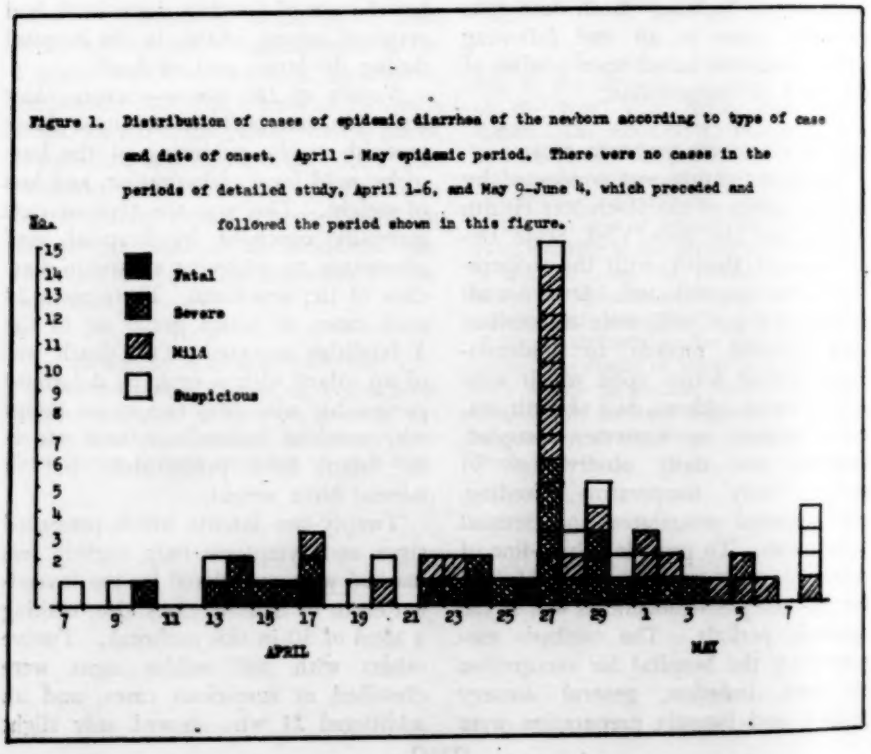

Figure 1. Distribution of cases of epidemic diarrhea of the newborn according to type of case and date of onset. April – May epidemic period. There were no cases in the periods of detailed study, April 1-6, and May 9-June 4, which preceded and followed the period shown in this figure.

their occurrence was limited to the epidemic period. Subsequent tables omit suspicious cases and group the severe and mild cases together.

TABLE 1

Distribution of Infants and Cases of Diarrhea, According to Nursery

Nursery	Date Opened to Admissions	Date Closed to Admissions	No. of Infants Admitted	Number Ill	Per cent Ill
H1-A	Prior to Apr. 1	Apr. 24	33	12	36.4
H2-A	Prior to Apr. 1	Apr. 28	121	30	24.8
H2-B	Apr. 27	May 1	9	3	33.3
H3	May 1	May 4	15	5	33.3
H2-Prem.	May 5	*	5	0	....
H1-B	May 5	*	58	0	....
H2-C	May 11	*	85	0	....

* Still open June 4

Nurseries affected—Table 1 shows the distribution of infants and cases according to nursery. The number of infants for nurseries H1-A and H2-A is made up of those infants in such nurseries on April 1 and those admitted subsequently. A few infants who died or left the hospital shortly after birth are excluded from the figures. Fifty cases of diarrhea occurred among 178 infants at risk April 1 to May 5, a rate of 28.1 per cent. The similar attack rates in nurseries H1-A and H2-A suggests that the factor or factors producing the illness were operating with approximately equal force in each. The first definite case occurred in H2-A on April 10 and in H1-A on April 14. The chronological distribution of cases was approximately the same in each of these nurseries and in each instance the peak incidence fell on April 27. The first case occurred in H2-B 5 days, and in H3 5 days after these nurseries were opened.

Relationship to type of feeding—It was customary in this hospital to give routinely only 5 per cent lactose for the first 2 or 3 days of life; subsequently most infants were put to breast and given supplementary feedings of whole or evaporated milk formula. Thus every infant had some exposure to the possibility of infection by contaminated nipples, bottles, and lactose or formula. A small number were never put to breast, and a very small number never received any formula.

Table 2 shows the attack rate according to type of feeding for 177 infants for whom data are available at risk during the epidemic period. Although the numbers on which these rates are based are small, there appears to be a definite trend toward increased risk of attack as the amount of artificial feeding increases and breast feeding decreases. There is no statistically significant difference between evaporated and whole milk, either alone or

TABLE 2

Attack Rates According to Type of Feeding

April-May Outbreak

Type of Feeding	No. of Infants	No. Ill	Per cent Ill
Breast milk and lactose	9	1	11.1
" " " whole milk	60	11	18.3
" " " evap. milk	75	19	25.3
Evaporated milk only	17	8	47.0
Whole milk only	10	5	50.0
Other (dry milk, etc.)	6	5	83.3
Totals	177	49	27.7

in conjunction with breast milk. Grouping the types of feeding it is found that, whereas only 21.5 per cent of 144 infants receiving breast milk and supplement became ill, 54.5 per cent of the 33 receiving formula alone became ill. This difference, which is statistically significant, emphasizes the association between risk of attack and type of feeding. Similarly, only 16, or 11.1 per cent, of infants receiving some breast feeding developed severe cases while 12, or 36.4 per cent, of those receiving only formula became severe cases. On this evidence alone, however, it is impossible to state whether breast milk confers a protective effect or whether formula carries increased risk of infection.

TABLE 3

Attack Rates According to Birth Weight

Birth Weight *	*No. of Infants*	*No. Ill*	*Per cent Ill*
Less than 4.75 lb.	2	0	..
5.25	7	4	57
6.25	30	5	17
7.25	65	13	20
8.25	58	22	38
9.25	14	6	43
More than 9.75	2	0	..
Totals	178	50	28.1

* Grouped to nearest indicated weight

Relationship to birth weight—Table 3 shows that in this outbreak overweight as well as underweight infants apparently were somewhat more susceptible than those of normal birth weight.

Sex—There were 28 cases in males, 22 in females. All 3 deaths occurred in males.

Age—In the absence of knowledge of the date of effective exposure it is impossible to fix the incubation period. Table 4 shows the distribution of cases according to the day following birth in which first symptoms occurred. The median case fell on the 5th day. The most interesting feature of this table is the indication that the incubation period may be as short as 24 hours. The brevity of this period suggests an infectious or toxic agent received by ingestion, paralleling the experience with gastroenteritis in older children and adults.

TABLE 4

Distribution of Cases by Day of Onset

Onset: Days after Birth	*No. of Cases*
1	3
2	3
3	5
4	10
5	6
6	7
7	7
8	4
9	1
10 and over	4
Total	50

Mode of transmission—The medical histories of the mothers and the causes of illness among nurses absent from duty or cared for by the institutional medical service were reviewed without gaining any information as to the manner in which the agent responsible for the outbreak was originally introduced.

There was little opportunity for direct contact, the bassinets being kept in cubicles with intervening partitions 2 feet in height. Breast-fed infants were conveyed to mothers in a large carrier, a partition 10 inches high separating the infants. Although in these circumstances respiratory spray from one infant might reach another, none presented any respiratory illnesses which would forcibly eject such a spray for a great distance. Transmission of infection by equipment did not seem likely since individual tubs, toilet articles, and thermometers were used, infants were diapered in their own bassinets, and a clean drape was placed on the scale before weighing each infant.

Some degree of transmission through breaks in nursing technic seemed quite possible although the evidence was indirect. In the previous year the hospital averaged about 100 deliveries

per month, but the phenomenal rise in the birth rate in 1942 increased this rate to more than 150 per month. Coincidental with the increase there was difficulty in securing sufficient and well trained nurses. Prior to and in the early weeks of the epidemic the nurseries were understaffed, it being reported that on occasion a single nurse might be responsible for the care of 30 or more infants for a period of hours, and it was indeed observed that one nurse would frequently be caring for as many as 20 infants at one time. The ratios of infants to nurses far exceeded minimum standards. In the large nursery, H2, bassinets were in two adjoining rooms, yet a sink was provided in only one. In the several nurseries nurses were occasionally observed to wash their hands only perfunctorily after diapering an infant and to use cold or tepid water and very little soap. Until May 2 or 3 the routine provided for diapering infants before feeding, thus increasing the risk of transmission of infection if a break in technic occurred.

As reported previously,[1] rubber nipples have been suspected as a vehicle of infection. In this hospital they were washed in the nursery after use, placed in a vessel of boiling water for a period of 3 to 15 minutes, removed with sterile forceps, and placed in a sterile covered jar until the time of the next feeding when they were applied to the bottles by hand by the nursery nurse. No precautions were taken to insure complete submersion of nipples in the water. The period of boiling seemed rather short in view of a finding some weeks previously by the obstetrical supervising nurse that satisfactory bacteriological results were not obtained with less than a 20 minute period.

The possibility of transmission through contaminated formula[1] was seriously considered in view of the nearly simultaneous onset of the epidemic in the two nurseries operating in April, the explosive occurrence of cases on April 27, and the similar course of the epidemic in both nurseries. Formula was prepared in a room which was well equipped but obviously too small for the purpose. Bottles were boiled for 15 minutes before being filled. Whole milk formula, water and 5 per cent lactose solution, were reported to be boiled prior to filling bottles. Evaporated milk was boiled in the can, added to Karo and boiled water in a graduate, and the mixture poured into bottles. Powdered milk formulae were made with boiled water but the resultant mixture was not boiled. After the nursing bottles were filled a boiled rubber cap was applied. Some were sent to the nurseries to be refrigerated until needed and some, together with additional formula held in reserve in quart bottles, were stored in the formula room refrigerator. Failure to defrost often and frequent opening of the refrigerators cast some doubt as to the adequacy of refrigeration. These preparations were carried out by one or more student dietitians and a maid, under supervision of the chief dietitian. Other demands on the time of the latter were so great that close supervision was not maintained.

Nipples and formula which were ready for use by infants were secured at random under sterile precautions, and examined by the Rochester Health Bureau Laboratories and the Division of Laboratories and Research, New York State Department of Health. Total bacteria counts were obtained for nipples by swabbing outer and inner surfaces with a sterile swab moistened in buffered dilution water, reimmersing the swab in 2 ml. of the water and then plating out 1 ml. Counts were obtained for formulae by the standard plate count method for milk examination.

TABLE 5

Total Bacteria Counts Obtained upon Examination of Rubber Nipples and of Formula

	Nipples: Total Bacteria per Entire Surface				*Formula: Total Bacteria per ml.*			
Date Prepared	*No. of Samples*	*Maximum*	*Median*	*Minimum*	*No. of Samples*	*Maximum*	*Median*	*Minimum*
April 30					7	180	60	20
May 1	2	>160,000	....	>160,000	1	10	..	10
2	20	>160,000	6,500	60	0	..	..	..
4	19	>160,000	7,000	28	2	150	..	10
5	7	16	4	<4	5	470,000	70	10
6	14	8	0	0	15	550	80	10
7	1	2	..	2	2	12,000	..	2,000
10	5	6	0	0	7	540,000	100	0
11	4	76	0	0	4	100	0	0
12	6	4,300	42	0	6	30,000	0	0
14	2	6	..	2	2	2	..	0
17	4	4	2	0	4	0	0	0
21	5	4	2	0	5	500	0	0
22	2	4	..	0	2	300	..	200
24	2	0	..	0	2	200	..	0
25	1	2	..	2	1	0	..	0
28	3	4	0	0	3	100	1	0
Totals	97				68			

Table 5 shows the number of samples examined and the maximum, median, and minimum counts for the indicated day. Caution must be used in reading the results for formula examination; on May 5 the count next highest to the one of 470,000 was only 200; on May 10 the count next highest to the one of 540,000 was only 200, and on May 12 the count next highest to the one of 30,000 was only 600. A definite reduction in the counts for nipples is observed beginning with reorganization of the formula room May 5. Improvement in formula counts is not so noticeable until May 11. Organisms of the coliform group, indicating contamination presumably of fecal origin, were found on April 30 in 2 samples of formula, May 5 in 1 and May 12 in 1. They were found May 1 on 2 nipples, May 4 on 7, and May 12 on 3.

Diagnostic laboratory findings—53 fecal specimens from 17 sick infants were submitted to the Division of Laboratories and Research for examination. None of the bacillary incitants of enteric disease nor any other microörganisms of recognized diagnostic significance were found. Marion B. Coleman of the Division of Laboratories and Research, New York State Department of Health, kindly repeated the work described in a previous communication.[1] Two or more baby Swiss mice were inoculated intraperitoneally with ether-treated portions of each specimen and in addition single fecal specimens from each of 10 infants in a second hospital in Rochester were similarly examined as controls. The results are summarized in Table 6.

Grouping the severe and mild cases, it is found that 39 per cent of inoculated mice died, and grouping the normal controls, only 11 per cent died. Or, considering infants whose feces contained some principle capable of killing mice, 70 per cent of the severely ill possessed this property; while 53 per cent of the severe and mild cases together, and only 27 per cent of the control cases had this property. These data have been so presented as to minimize the apparent difference between sick and well infants and taken as they stand may not appear conclusive. However, taking into account the factors mentioned in the footnotes to Table 6, particularly the prolonged incubation period in fatal instances in

TABLE 6

Lethal Effect upon Baby Swiss Mice of Injection of Ether-treated Suspension of Feces from Infants

Diagnosis in Infants	*No. of Infants*	*No. of Fecal Spec.*	*No. of Mice Inoculated*	*Per cent of Mice Dying*	*Per cent of Infants Whose Feces Caused Death of Mice*
Hospital A					
Severe case	10	36	80	42	70
Mild case	7	17	30	27 *	28
Normal	1	4	8	..	..
Hospital B					
Normal	10	10	20	15 †	30
Totals	28	67	138	33	43

* Of the 8 deaths upon which this percentage is based, 7 occurred among mice inoculated with specimens from a single infant.

† The 3 deaths upon which this percentage is based occurred 6, 7, and 15 days following inoculation, in comparison with a usual period of 1–4 days in mice dying in the other groups. In each instance a mouse inoculated with a portion of the same specimen survived.

NOTE: 4 infants in the "severe" group were receiving sulfaguanidine. For 2 of these all mice survived; for 2 others 13 of 28 mice died.

the control group, it appears justifiable to interpret these findings as showing that some agent lethal for mice is frequently present in feces of infants suffering from diarrhea of the new-born. Unfortunately, this agent has not been identified. The relatively infrequent association of this effect with feces of mildly ill infants may have been due to improper diagnosis or a lesser concentration of the agent in the feces, or both.

Control measures—Prior to the investigation, control measures had consisted of instituting gown technic on April 28, isolating very ill infants by transfer to the pediatric nursery, vacating and washing nursery H1-A, closing H2-A to admissions, and establishing H2-B for new admissions on the dates indicated in Table 1. Mild and suspicious cases were not usually recognized and isolated, and since there was no one person responsible for detecting and ordering isolation of cases it was not uncommon for a day or two to elapse between onset and isolation of a recognized case. The measures described did not seem conspicuously successful, although one cannot state with certainty what the actual outcome would have been had no additional measures been imposed.

On May 1 arrangements were made for the detection of ill and suspiciously ill infants according to the criteria described in the section on diagnosis. Being an attempt to determine infectiousness and based primarily upon feces rather than clinical condition, this standard resulted in the classification of some infants as definite or suspicious cases at a time when their general condition seemed satisfactory to the clinicians. Considerable friendly dispute with clinicians arose thereby, but the standard was rigidly adhered to and all such infants were required to be isolated.

Specific recommendations were made for preparation of nipples and formula in the central formula room. Formula for a 24 hour period was to be made up and subsequently boiled before filling autoclaved bottles; nipples boiled 30 minutes while completely submerged were to be applied to the bottles in a sterile field using aseptic technic; nipples were to be covered with an autoclaved metal cap; and the whole was to be immediately refrigerated.

Assuming that these recommendations would be carried out immediately, a new nursery, H3, was opened May 1 to receive newly-born infants who would have had no contact with others

and who would receive sterile food and drink. Well infants in other nurseries were to remain where they were unless they became ill and required transfer to the pediatric nursery, or until they were discharged home. Establishing H3 was not a successful venture; one-third of the 15 infants admitted within the next 5 days became ill, beginning May 4. The manner in which the disease was introduced is not known, but from a study of Table 5, it would seem reasonable to attribute it to failure to sterilize nipples, and possibly formula, until May 5. On the latter date the formula room was placed in charge of a nurse who taught bacteriology, with immediate improvement in bacteriological results. Under her direction the new procedure was routinized and was subsequently returned to the dietitians. Other control measures provided that infants be diapered after rather than prior to feeding, and placed emphasis on careful handwashing. A larger nursing staff and rearrangement of one of the nurseries were urged.

Having attained satisfactory technic in the formula room, new nurseries, H1-B and H2-Prem, were opened May 5 (see Table 1). No cases occurred among infants born on this date or thereafter for a period of daily study extending through June 4. The cessation of the epidemic following these measures may have been due to prompt recognition and isolation of cases, or improvement in nursing technic, or proper sterilization of nipples and formula, or some combination thereof.

SECOND OUTBREAK: JULY, 1942

After June 4 daily observations were discontinued in the expectation that satisfactory conditions would continue, but on July 22 the hospital reported the recent occurrence of a number of cases of diarrhea. An investigation undertaken in the manner previously described revealed that the nurseries had remained free of diarrhea from June 4 until July 8 and 9 when 3 rather mild cases occurred in H1 nursery. These were not isolated but the outbreak subsided spontaneously. On July 17 an infant in the H1 nursery developed loose stools and was not isolated but, following this, cases began to appear as shown in Table 7.

TABLE 7

Distribution of Cases of Diarrhea among New-born Infants According to Date of Onset and Nursery of Occurrence

Date	H1	H2	H3	Total
July 10–16	..	..	Closed	0
17	1	..	"	1
18	..	..	"	0
19	..	1	"	1
20	4	2	"	6
21	..	2	"	2
22	..	5	..	5
23	..	1	..	1
24	..	..	..	0
25	Closed	..	3	3
26	"	..	..	0
27	..	..	Closed	0
28	..	..	"	0
29	1	..	"	1
30	..	..	"	0
31	..	..	"	0
Aug. 1	..	..	"	0
2	..	..	"	0
3	..	1	"	1
4–24	..	..	"	0
Totals	6	12	3	21

The majority of these cases were quite mild, resembling those classified as mild in the April-May outbreak, and there were no deaths. None of the bacillary incitants of enteric disease or any other microörganisms of recognized diagnostic significance were isolated from 11 fecal specimens from 6 sick infants. Twenty-two mice were injected as described previously. One mouse inoculated with material from the most severe case died 8 days later; the others remained well and showed no abnormalities when chloroformed and autopsied 3 or 4 weeks later.

The rather explosive occurrence of cases July 20, 21, and 22, and the similar attack rates of 24 per cent in H1, and 32 per cent in H2 nurseries suggested a common source of infection, probably nipples or formula. In

partial support of this hypothesis it was found that of 8 nipples prepared July 22, one showed a total count of more than 160,000 and others counts of 56,000, 8,000, and 4,400. These were chiefly spore-forming organisms, probably *Bacillus subtilis*. Of 8 samples of formula, only one had a high count, 29,000; this and two other samples yielded *B. subtilis*. Perhaps as a result of the attention focused on the formula room, results were uniformly good July 23 and after.

When feeding histories were analyzed, however, it was difficult to support the hypothesis of spread by contaminated nipples and formula. Table 8 shows attack rates according to feeding history for infants in the hospital July 18–23. Section A of the table classifies infants according to the type of feeding beginning from birth and indicates that in this outbreak breast feeding carried a great risk of attack. This finding was so contrary to what was expected that it was thought possible a number of infants classified in Section A as breast-fed might have gone to breast for only a few days in the preëpidemic period and subsequently received formula as a supplement or alone during the period beginning with the onset of the first case on July 17. Section B of Table 8 classifies infants according to the type of feeding in the period July 17–20. This analysis brought out even more strikingly the risk of breast feeding and the safety of artificial feeding under the conditions prevailing, and directed attention to breast-feeding technic.

It was found that under the stress of a shortage of nurses the practice had developed in each of the two nurseries of providing a single breast tray containing a vessel of 4 per cent boric acid and one of cotton pledgets. Infants were diapered, etc., prior to being taken to the mother for breast feeding. The nurses would then dip cotton pledgets in the boric acid and with the fingers squeeze the excess fluid back into the vessel. Infants were carried to the mothers, the pledgets were used to cleanse the nipples and the infants were then put to breast. The cotton pledgets as such did not fall under suspicion because a fresh supply was received daily from the carefully controlled central autoclave. There remained the possibility that a nurse might contaminate the boric acid solution with her fingers and if the organisms survived for even a short time contamination could be transmitted to the nipples of a number of mothers and thus to their infants.

F. Wellington Gilcreas of the Division of Laboratories and Research, New York State Department of Health,

TABLE 8

Attack Rates According to Type of Feeding History—July Outbreak

A. According to Feeding from Birth

Type of Feeding	*No. of Infants*	*No. Ill*	*Per cent Ill*
Breast milk and lactose	14	9	64
" " " formula	24	9	38
Formula alone	8	0	.
Totals	46	18	39

B. According to Feeding from July 17

Breast milk alone	2	2	100
" " and lactose	13	9	69
" " and formula	15	7	47
Formula alone	16	0	..
Totals	46	18	39

TABLE 9

Fate of Organisms Inoculated into 4 Per cent Boric Acid and Allowed to Remain There for Indicated Time

Time in Minutes	Fraction of Original Culture	Average Count per ml. in Suspension		
		E. Coli	*S. aureus*	*S. faecalis*
<1	1/1,000	180	0	TMC*
	1/100,000	1	0	1,700
5	1/1,000	50	0	TMC
	1/100,000	1	0	1,400
15	1/1,000	27	0	TMC
	1/100,000	0	0	1,400
45	1/1,000	7	0	TMC
	1/100,000	0	0	1,300
75	1/1,000	8	0	TMC
	1/100,000	0	0	2,300

* TMC = too many to count

prepared suspensions of *Escherichia coli*, *Staphylococcus aureus*, and *Streptococcus faecalis*, and inoculated them into 4 per cent boric acid and into distilled water. At the intervals indicated in Table 9, portions were removed and the average count per ml. determined. With both 1:1,000 and 1:100,000 dilutions there were too many colonies to count in case of all three cultures which were inoculated into distilled water. In 4 per cent boric acid *S. aureus* failed entirely to survive and only a few organisms of the coliform group survived, but *S. faecalis* was not affected. It is not held that *S. faecalis* was the etiologic agent in this outbreak but it does seem reasonable to assume that some type of organism capable of surviving for some time in 4 per cent boric acid was at fault.

As in the previous outbreak sick infants were promptly isolated in a separate nursery (H3). By July 25 the probable mode of transmission was sufficiently appreciated to lead to the recommendation that breast technic be revised. Effective control seems to have been attained shortly thereafter by the use of forceps to handle the pledget, although one case occurred in a formula-fed infant July 29, and one in a breast-fed infant August 3. The technic was later revised to provide for individual pledgets on wooden applicators. No further cases were recognized during a period of close observation concluded August 24.

In explanation of the approximately simultaneous outbreak in the two nurseries is the fact that shifts of nurses occurred at a time and under conditions which would permit the development of cases by the spread of infectious material from the case developing July 17. The greater incidence of cases among those receiving breast milk and lactose solution than among those receiving breast milk and formula is perhaps due to the fact that on the average the former were put to breast more often, and without fail during the night when lapses in technic were more likely to have occurred.

SUMMARY

1. An epidemic of diarrhea of the newborn consisting of 22 mild and 28 severe cases, with 3 deaths, occurred in a Rochester, N. Y., hospital in April and May, 1942.

2. The etiological agent was not determined. Evidence was secured that the feces of sick infants contain an agent fatal to baby Swiss mice in significantly higher proportion than feces of well infants.

3. The incubation period was observed to be as short as 24 hours in 3 cases. The disease tended to select infants below and above normal birth weight. Two of the 3 deaths occurred in infants with birth injury or congenital abnormality.

4. The incidence of illness was significantly greater and more severe among infants artificially fed than among the breast-fed.

5. Opportunity for transmission of infection was afforded by contamination of nipples and formula. Delay and inadequacy in recognition and isolation of cases may have been contributory. The epidemic came to a close following correction of these faults.

6. A second epidemic of diarrhea of the new-born consisting of 21 mild, non-fatal cases occurred in the same hospital in July, 1942.

7. Illness was limited almost exclusively to breast-fed infants. Opportunity for transmission of infection was afforded by probable contamination of a common vessel of 4 per cent boric acid used to cleanse the breasts. The epidemic came to a close following correction of this fault.

CONCLUSIONS

Epidemic diarrhea of the new-born is a disease in which the unidentified etiological agent is present in the intestinal and possibly oral discharges of sick infants. The occasional introduction of the disease into a nursery, probably from an inapparent adult source,[2] is difficult to prevent. If routine technics permit transfer of infectious discharges through contamination of nipples, formula, and breasts, or indirect transmission by attendants, an epidemic will occur when the infection is introduced. Insufficient or inadequately trained personnel and faulty equipment contribute to the opportunities for transfer of secretions and excretions. Prevention and control depend upon laboratory controlled methods of sterilizing nipples and formula, good nursing technic, prompt recognition, reporting and isolation of cases, and immediate epidemiological investigation by a competent person, which ordinarily will mean by an epidemiologist in the health department.

REFERENCES

1. Lembcke, P. A. Imperfect Sterilization of Nursing Nipples and Formula as a Possible Factor in Transmission of Epidemic Diarrhea of the Newborn. *Am. J. Hyg.*, 33:42–50 (Mar.), 1941.

2. Lembcke, P. A. Prevention and Control of Epidemic Diarrhea Is the Administrator's Responsibility. *Mod. Hosp.*, 60:98–102 (Mar.), 1943.

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THE WAGNER-MURRAY BILL

THIS bill makes physicians conscious that the heretofore vague shadow of socialized medicine is becoming foreshortened and of some substance. They realize that if this bill were enacted into law the practice of medicine would be changed, and quite definitely changed, for it would place under government auspices medical and hospital care for the great majority of the population of the United States. Funds for the service would be provided through pay roll deductions as a part of the general social security program. Organization would be on a federal basis, physicians being employed through the Surgeon General of the U. S. Public Health Service. Hospital and auxiliary care would be under the same direction.

There would be an Advisory Council, appointed by the Surgeon General from nominations submitted by medical and other organizations. In the program itself, a given physician would participate or not as he chose; he might participate on a fee basis or per capita, or on part- or full-time salary. A beneficiary would have the right to choose his physician from among those participating. The physician would retain the right to accept or not accept a given patient, unless perhaps that physician were employed on a salary basis.

The reaction of most well established physicians in opposition to this bill has been definite, even vehement and bitter in some quarters. An editorial in the *Journal of the American Medical Association* (June 26, 1943) reviews the genesis of the bill, pauses to point out that while "spell of sickness," used in the bill, is poor English, it is at the same time evidence that the medical profession was not consulted as to medical provisions; uses the word "gauleiter" as descriptive of the position of authority proposed for the Surgeon General of the Public Health Service, presents some "quotes" from the bill indicating the extent of that power, and ends by quoting from the Chicago *Daily News* to the general effect that the worker's zeal for social security will be dampened by ever-mounting pay roll deductions inherent in such schemes.

Another editorial in the September 4 issue of the same *Journal* summarizes the June 26 editorial, even to the "gauleiter" term, quotes further from news-

paper editorials unfavorable to the bill, takes cognizance of an editorial, not pro-organized medicine in character, in *Medical Care* (August, 1943), and calls upon the medical profession to prove to Senator Wagner and his colleagues, " by a complete and forceful presentation of the points of view of American Medicine, how far from perfect is the measure (the Wagner-Murray bill) he has proposed."

Another evidence of opposition to the bill is to be found in a pamphlet released and distributed to physicians by the National Physicians' Committee for the Extension of Medical Service. This committee's views on medical care have in the past appeared to reflect the opinions of leaders of organized medicine, and the pamphlet itself tends to emphasize the probable and possible ills and, one cannot help but feel, some imaginary ills that physicians and the public would suffer if the medical service proposals of the Wagner-Murray bill are enacted into law. In contrast, the Committee of Physicians for the Improvement of Medical Care, Inc., which has seemed generally inclined toward government-arranged medical care and does not see eye to eye with organized medicine nor with the National Physicians' Committee, has issued a statement congratulating Senator Wagner on presenting the bill, designates it as a framework and a basis for discussion, and expresses the hope that the Committee of Physicians " will be given an opportunity to participate in the discussions of the bill and to offer its advice and suggestions." An editorial in *Medical Care* has been referred to above.

Thus, to date, there have been only preliminary skirmishes. Opponents of the bill, for the moment, appear to be the more active. Possibly this is because those who favor the medical service proposals count upon the popularity of unemployment benefits and pensions to overcome opposition to the proposals for socialized medicine, the latter being only part of the broad program of social security which this bill is designed to provide. No one person may announce for the American Public Health Association a policy or attitude in regard to this proposed legislation. Only the Governing Council may make a statement of that sort. This much, however, may be said editorially. Most of those who are not emotionally prejudiced in favor of or against this bill see in it provisions that seem reasonable and necessary and implications that may be dangerous. So far as concerns the medical service element, neither its virtues nor its vices would in practice be so superlative as proponents and opponents respectively prophesy. As regards quality and quantity of medical care, some of the present disabilities and deficiencies would perhaps disappear but, at the same time, much that is fine might too disappear. Thus, though care would be more nearly assured to the population at large, that care would inevitably be burdened with the by-products of red tape, perfunctoriness and mediocrity inherent in most civil services, and possibly with some politics.

It is the general implications of the bill, more than the specific medical elements, that cause apprehension among those who attempt to view the matter dispassionately, in that this legislation would introduce socialization on a vast scale, and contemplates an entirely federal administration with complete disregard of state boundaries and sovereignty. It would thus commit the American people to an entirely new order of life, one which heretofore has been experimented with only in a superficial and dilettante fashion. Maybe the ends justify the means, maybe the complexity of the social and economic order of the United States makes the bill necessary and wise. One might wish, however, even though doubting the success of a voluntary scheme, to see some experimentation with less compulsion as to who must be beneficiaries; equally, while one might suspect

that a federally administered medical service would be more effective than the average state administered service, it would seem precipitate, without trial, to exclude state participation so completely as this bill contemplates. Federal-state coöperation has worked admirably in public health matters. In any event, one needs carefully to consider the price, other than financial, that would be paid for the security that this bill is designed to provide.

Whether or not the Wagner-Murray bill is enacted into law, it seems likely that a bill providing medical service of some sort and extent will be passed by the Congress before very long. If this is the case, it would be the part of wisdom for those who are interested in preserving the fine traditions of private medical practice and of private medical research and medical education, to offer some alternative plan or scheme which may do less violence to independent medicine on the one hand and which at the same time would insure to the average citizen a high grade of medical care. Continued blind and hair-splitting resistance, by physicians, to any and all proposals for some degree of public medical service will but tend to strengthen the contention of those who insist that the medical profession is unreasonable in its attitude, selfish in its interests, and lacking in constructive leadership. Convinced of this, the public may give support to legislation detrimental to real progress in medical science and not to the best interest of the people of the United States.

ON THE NEED FOR BASIC KNOWLEDGE

IN recent years and under the stimulation of a somewhat aggressive pedagogical philosophy, there has arisen a tendency to believe that if one knows how to teach or to analyze or administer, then a thorough knowledge of the thing to be taught or analyzed or administered is of but secondary importance.

Out of such a concept, perhaps justifiable up to a certain point, there has developed an alarming smugness among the ill-informed. Not only do these people irritate their betters in the public health field, but, potentially at least, they are in position to do much harm. We concur in the thesis that public health workers must be disciplined to analyze and to synthesize mentally, and we agree that one should not accept encyclopedic knowledge as a test of mental capacity. On the other hand, in modern public health work one must be armed with more than an ability to think straight, even though this ability is a commendable and rare one. In addition, it is necessary that physicians, nurses, engineers, dentists, health educators, and others carrying on health services possess both fundamental knowledge in the sciences basic to public health and detailed information in the special categories in which they work.

These things seem worth mentioning for two reasons. First, because young workers in public health, sometimes discovering an astonishing and distressing lack of technical knowledge in their superiors, may be misled into a belief that ignorance is no barrier to promotion and prestige. It must be admitted that persons rather ignorant professionally do sometimes get along fairly well in the public health field. This, however, is quite the rare exception. When it occurs, the individual concerned possesses some element of personality, force, or smoothness that masks deficiencies in knowledge; or perhaps by his own shrewdness or with the help of his patrons he has been able to grasp time by the forelock. Similar accidents

occur in other fields, too, but the average uninformed person has no grounds and no right to hope that it will happen in his case. The second reason for discussing the necessity and worth-whileness of obtaining and retaining basic scientific information is that young workers in the public health field are inclined erroneously to assume that one may grow in knowledge only by attending formal courses of instruction. This is not true. If one really wants to add to his store of information, there are no places or circumstances in continental United States where, through one means or another, the necessary texts, facilities, and equipment cannot be obtained, providing the urge to knowledge is strong enough. Nor is the opportunity and necessity for learning limited to the younger workers in the public health field. Health officers, executive secretaries, directors, and, if they are diligent, professors, may hope to acquire basic and detailed knowledge of public health.

A side light on what may happen when the uninformed get to chucking their weight about is illustrated by the case of an examiner, in a profession supplementary to medicine, who was long on method but short on fact. Scorning the old-fashioned questions that required narrative answers, she examined by the multiple choice technic and asked candidates to decide whether it is in malaria, typhoid fever, or pneumonia that *Peyer's patches* are found.

Credit Lines

THE COMPLEAT (ANNUAL) REPORTER

AT the request of the Editors of Credit Lines, an Izaak Walton went angling in a sea of health department annual reports a little while ago. Our Izaak is RAYMOND S. PATTERSON, PH.D., Director of Health Education, John Hancock Mutual Life Insurance Company, Boston. Now he displays the contents of his creel. The next voice you will hear will be that of Dr. Patterson.

What's an annual report? Seems a pointless question to ask, doesn't it? But there is plenty of evidence spread out upon my desk to suggest that the question has never occurred to a good many health officers. If, as you will tell me, an annual report is a year's end accounting of the activities of a health department made to the residents of the community, who have every right to know what their health department does for them, then one would suppose the annual report would be, in effect, a message something like this:

Dear Squire (or Dear Mrs. Nabob): Your health department performed these several services to protect and promote your health during the year. We wish that we might have done thus-and-so for you, but we were prevented for these reasons. If you want figures to support our statements, here is a mercifully condensed DIGEST of the complete compilations which are on file in our office and always open for your inspection, so we won't bore you with the details here. If you would like to know the names of your hired help in the health department, here at the close is the staff. We thank you.

Such a yearly "news letter" written in a pleasing and sprightly style, illustrated with *new* pictures, not too posey, would be read with interest by many of the influential people in town to whom it should be sent, and it would be snapped up by the editor of the local Tageblatt for a news story (perhaps with a nudge from you).

The reason I asked the question, "What is an annual report?" is that most of the tomes displaying that label, and which have come to this desk from a score of American communities, bear so little resemblance to what one would assume a report would be like.

Here is a sort of composite photograph of the majority of city health department reports, with my ill-natured comments in italics.

Title page announces the breathless news, "Annual Report of the Department of Public Health of the City of New ———— 1942." *Why not give your report a title which "says something" about the nature of the year's work. The words "annual report" long ago earned a reputation for deadly dullness.*

Page 1: Long lists of city officials, board members and complete staff of the health department down to the bottle washers in the lab.

These names are chiefly of interest to the owners thereof. If the record is needed why not put it at the back, as a sort of signature to the report? Readers will appreciate your help in getting quickly to the point, if any, of your story.

Page 2: Stilted letter of transmittal to his Honor, the Mayor, and the Honorables, the Members of the Common Council.

Ho! Hum! The reader sighs, maybe we'll get through this verbal trash pretty soon!

Pages 3 to 7 or 8: Mortality statistics, morbidity statistics, plain statistics—about nursing visits, sanitary inspections, and numbers of deceased felines removed from gutters.

By what reasoning do you suppose all the able health officers, who are responsible for these reports, come to the conclusion that readers will wade through these long tabulations? And if they did, would they remember anything useful about local public health administration when the reading was done? (Both questions are rhetorical.)

Pages 9 to 12: Uninspired narrative reviewing in most prosaic words possible to find, every single activity of the health department throughout the year; with newsworthy items smothered between "the same old stuff."

Dear Doctor Health Officer: Your report is a letter (in effect) telling the Squire a few things he should REMEMBER about your activities of the year! So dress it up. Use "picture" words, and real pictures too if you can get good ones! Accent the high lights with flashes of descriptive writing! Don't put your reader to sleep!

We've said enough! Too much, in fact.

. . . .

From among several excellent reports I select this annual accounting from the Southland as a good example of the way it might be done.

The cover of this 16 page, photolithographed and economically printed brochure is eye-catching, with a striking silhouette of a statue of a soldier on guard. The title is "Keeping Watch," the place is Forsyth County (Winston-Salem, North Carolina), the year is 1942.

The foreword "Keeping Watch—Over Health" reminds the reader that the job is a responsibility in which he has a definite part, to look after his own and his family's health and to take an intelligent interest in the public's health. A striking contrast of photographs of business tower and share cropper's cabin drives home (on p. 3) the point that public health is the health of *all* the people. On the pages that follow is told the story—in unposed, convincing pictures, with captions that "say something" about them, not mere labels—of the health department's services for expectant mothers, infants, toddlers, and school children, and how it helps to guard against communicable diseases, including tuberculosis and syphilis, and what it does to improve community sanitation. At the end of the story is listed the staff.

A postscript entitled "Good . . . But Not Good Enough" reproduces the citation of the Inter-Chamber Rural Health Conservation Contest and under the picture of a bright-eyed urchin, are listed all the laudable and reasonable objectives to which the department is "Looking Forward."

That, good friends, is one swell report. To its producers I doff my cap, mightily impressed with the interpretative brains, the sparkling ingenuity, and the plain hard work that went to make it what it is.

There are other good reports that might have been mentioned: the always excellent New York City year book, for instance. But had that one been chosen, many readers would have shrugged it off with a "Why shouldn't New York have a good one? Now in my case . . ." Birmingham, Alabama, again "rings the bell" with a report entitled "Public Health and a National Emergency." But Winston-Salem's deserves to stand out sharp and clear, not to be overshadowed by the competition of publications from bigger and wealthier places.

RAYMOND S. PATTERSON

ADVICE ON LANTERN SLIDES

Dr. James E. Perkins, Director of the Bureau of Communicable Diseases, New York State Health Department, is Secretary of the Association's Epidemiology Section. He has just sent a mimeographed letter to all the speakers on his Section program at the Wartime Conference in New York City, October 12–14, giving some excellent advice on the preparation of stereopticon slides. Because slides are so generally used to illustrate scientific papers, we share his communication with *Journal* readers. Unfortunately we cannot reproduce the effective examples referred to in the second paragraph, but Dr. Perkins would be glad to send copies, we feel sure, to any inquirers. The text provides a good idea of what they are. This is the letter:

TO ALL SPEAKERS ON THE PROGRAM FOR THE EPIDEMIOLOGY SECTION, AMERICAN PUBLIC HEALTH ASSOCIATION:

An excellent paper can be ruined by lantern slides which are not legible or fail to present the message which the speaker wishes to convey. No doubt you, yourself, have at times groaned when a slide has been thrown on the screen which was legible only to those sitting in the first two rows (if to them). Hence, this routine communication to all speakers on the Epidemiology Section Program, suggesting care in the preparation of slides.

The slide should be a condensation of the important points, and not a work sheet. Example 1 shows the type of table that is really a work sheet and has too much data to enable the audience to grasp the material contained therein. Because of the numerous categories, the figures on such a table will be visible only to the first row or so. Tables as complicated as this have not infrequently been presented before the Section. Such a table should be broken down into several simple tables. Example 2 shows a condensation of part of the data given in Example 1, and represents a slide actually presented before one of the meetings of the Epidemiology Section. Some of the other data in Example 1 were presented in separate equally simple slides.

Remember that the tables used in the slides do not have to be the same tables in the paper presented for publication. Published tables can be more elaborate and contain more data, since the reader can study them at his leisure, but tables used for lantern slides should give only the essential data necessary to make the point desired.

Material on the slide should be not more than fifteen lines deep (and preferably about half that) and contain not more than half a dozen categories horizontally. If such data are well distributed over the slide, the projected image will be legible at the rear of the average size meeting room with the usual projector and usual screen.

Summarizing, then, please attempt to have your tables for lantern slides (1) present only the condensed summary of the important points, (2) comprise not more than fifteen lines, including the title, and not more than six columns across, (3) be so composed and so prepared by the slide maker that this material covers the slide, so that proper magnification will occur upon projection.

We will do our part by seeing to it that there are provided a good screen and projector, in good working order.

LEST WE FORGET

Those of the younger generation who are inclined to forget what the sanitary base line was against which our recent progress may be recorded will find pleasure in reading Professor Yandell Henderson's essay "Recollections of a Street Corner Pump and the Progress of Sixty Years" in *Science*, Vol. 98, No. 2532, pages 25–28, July 9, 1943. It is an interesting account built around Professor Henderson's experience in Louisville, Ky., where he was associated with distinguished members of the Flexner family, Simon and Abraham.

DO YOU AGREE?

President Roosevelt's recent message to Congress requesting $400,000,000 for housing for war workers, thus bringing the total authorization for this purpose under the Lanham Act to $1,600,000,000, brings to mind a comment of Professor C.-E. A. Winslow, speaking before the Eleventh Annual Meeting of the National Association of

Housing Officials in New York City. Professor Winslow was roundly applauded when he said:

"We are all familiar with the signs customarily placed at the entrances of new housing projects for war workers pridefully crediting the projects to the local and federal agencies responsible for them. We should feel less apprehensive about the future if they were changed to read: 'This is War Housing, necessary but regrettable. To be demolished immediately upon the cessation of hostilities!'"

Subsequently, Commissioner Emmerich of the Federal Public Housing Authority, officially endorsed Professor Winslow's principle in his recommendations for post-war demolition of war housing. One plank in his program was that "Temporary housing built to substandard plans in order to save time and critical materials should be removed." In fact, there was rather wide agreement during the meetings of the National Association of Housing Officials that the glorified shoe-box dwellings built during the war (1,100,000 so far) must be got rid of promptly if the progressive housing movement is not to receive a serious black eye, and if public health and social workers are not to be confronted with new slum areas to harbor additional disease and misery.

A PATTERN FOR HANDLING REJECTEES

The Public Health Federation of Cincinnati, of which Bleecker Marquette is Executive Secretary, has published a 6 months' report on a consultation service for men rejected at the Cincinnati induction station whose cases were reviewed under the auspices of the Public Health Federation, in coöperation with the Cincinnati Board of Health. Those who are seeking to find a pattern of good relationships between a voluntary agency, the board of health, and the armed forces, would do well to review the way these consultations have worked out in Cincinnati. Although primarily emphasizing the rejections on account of tuberculosis, the report also includes the cases rejected because of heart disorder, hernia, mental defects, syphilis, and other causes.

QUOTABLE ITEMS

"The vast majority of persons will not see a known case of tuberculosis unless they visit a hospital. What they know about tuberculosis, therefore, will be what we tell them, what health education gets over to them, and what new traditions are established in regard to a disease with which most people have no personal contact. This situation calls for more and better, and more continuous, health education as to tuberculosis."—Homer Folks, July, *N.T.A. Bulletin*.

From a bulletin board in a Wisconsin mill where a tuberculosis survey was being made, "If every person in our mill but one has his lungs examined, that one is protected 100 per cent, but all the others are not protected from him."

"The efficiency of a board of health and the respect which will be shown it in a community will depend very much upon the firmness with which the members insist upon a strict compliance with all needful sanitary regulations as well as the caution they display in avoiding needless exactions and unnecessary investigations."—Honorable Leroy Parker in the *Annual Report of the Michigan State Board of Health for the year 1879* and published in *Health News*, New York State Department of Health, July 19, 1943, under the caption "Still True."

MORE ON EPIDEMIC VOMITING DISEASE

Apropos of an editorial entitled *Is There an Epidemic Vomiting Disease of Winter?* which appeared in our April issue, readers of the *Journal* may be

interested to know that an article on this subject was published in the March 13, 1943, number of the *British Medical Journal*. An abstract of the article appeared in the *Journal of the American Medical Association*, June 12, 1943. For this information we are indebted to Dr. John J. Sippy of California, who has himself studied epidemic vomiting outbreaks.

AWARDS FOR MILK PRODUCERS

J. L. Rowland, the Chief Sanitarian of the Oak Park, Ill., Department of Health, has announced a quality milk program offering to each milk producer a certificate of award " in recognition of noteworthy achievement in sanitation and quality milk production."

The requirements include a methylene blue test of 6 hours or more and bacterial counts not to exceed 200,000. The number of defects on the inspection sheet is limited. A persuasive letter explains the proposal to the milk producers and is signed by Gilbert P. Pond, M.D., Commissioner of Health.

THE OWI

The Office of War Information has been the ricipient of many brickbats and of few bouquets. We timidly approach with our nosegay. Of course anyone on their mailing list received a great deal of material before an unappreciative Congress curtailed their domestic activities. The reason is simple. This is a big war, affecting every one of us in every aspect of our living, and there was much to say about it. Naturally a large amount of what was said had nothing to do with the particular problem on your mind when the daily releases or special publications popped up in the morning's mail. But a good deal that was seemingly extraneous at the moment was genuinely informative to people aware of their century. These additions to general knowledge and background information were painlessly made. Further, and more practically, they could be drawn from or quoted (no copyright) to put the stamp of timeliness on a piece of printed matter or a speech to disguise the fact that the same old record was about to be played.

The " true story " about absenteeism, told by OWI, and one on British in-plant canteen services, to select two for mention from a great many quite as worthy, were for us as citizens first and as public health workers second—and good reading all the way.

News from the Department of Agriculture, from the Bureau of Mines, and from the Federal Security Agency, released in one day through OWI, all contained pertinent information for health workers and were published in the *Journal*.

The thorn in our nosegay to OWI is turned so that it pricks us. They made their stuff so interesting that many times the problem on our minds when the morning mail was tackled was still there at noon. That article on kok-saghyz, the Russian rubber-producing dandelion, for instance, contained not an implication that the plant has any food value to assuage our sense of guilt at having read every word. We are going to miss things like that and similar pieces of " fourth term propaganda."

MANUAL FOR VOLUNTEERS IN MASS CHEST X-RAY EXAMINATIONS

As an outgrowth of experience in chest x-ray examination projects on a large scale which were organized and conducted jointly by the Hartford Board of Health and the Hartford Tuberculosis and Public Health Society, a *Manual* has been prepared for guidance of volunteer crews that may be called upon to participate from time to time in such projects under health agencies.

The outline covers the services of the

supervisor, the dressing room attendant, the registrar and dark-room operator. Copies of the *Manual* may be obtained on request from the Hartford Tuberculosis and Public Health Society, Hartford, Conn.

WORTH ACQUIRING

Manual of Industrial Nutrition, first in a series to be prepared and distributed by the Nutrition in Industry Division, Nutrition and Food Conservation Branch, Food Distribution Administration, Washington, D. C. Contains brief chapters on the National Nutrition Program for Industry, on the nutritional status of industrial workers, basic and special considerations for an "in-plant" program and source lists of posters, pamphlets, films, news services, and radio scripts.

Leaflet on Meningococcus Meningitis, from Health Department, Baltimore, Md., Huntington Williams, M.D., Commissioner.

The Woman's Home Companion for June for its article "Change Your Food but Keep Your Figure"—reassurance that food rationing need not affect weight.

The Architectural Forum for May for its plans and drawings of the post-war hospital and health center.

The *Bulletin of the Health Organization of the League of Nations,* Vol. X, No. 1, devoted to Typhus Fever.

"What's More We Like It!" subtitled "Greenwich Answers to the Leaner Larder." Not every community has a Hendrik Willem Van Loon resident therein and not every Tuberculosis Association could induce him to illustrate a book of wartime recipes. The Greenwich, Conn., Tuberculosis Association has done just that and turns out a generous cookbook with all the right advice temptingly presented.

The February (Twentieth Anniversary) issue of *Channels* published by the National Publicity Council for Health and Welfare Services, Inc., 130 East 22nd Street, New York, N. Y., for its Publicity Directory which selects the most useful publications on how to use media and a list of major sources of publicity material (40¢).

Rheumatic Fever in Children—Its Recognition and Management, a 32 page clinical handbook written for the practising physician. A limited number of copies are available from George M. Wheatley, M.D., Assistant Medical Director, Metropolitan Life Insurance Company, 1 Madison Avenue, New York, N. Y.

The War and Social Problems—A Selected Bibliography, material to April 1, 1943, compiled by Karl A. Baer for the Russell Sage Foundation, 130 East 22nd Street, New York, N. Y. (20¢). References are classified under such headings as women, children, and young people, general health problems, nutrition, social hygiene, mental hygiene and morale, post-war planning, etc.

Radio Script No. 156, "The Story of One of Us," by Hubert Chain, published by the Radio Script Service and Girl Scout News Bureau, 155 East 44th St., New York, N. Y., for its dramatic handling of the experiences of American Red Cross nurses in Bristol, England, during the paratyphoid epidemic. It brings in the Medical Officer of Health of Bristol, Dr. Robert Hughes Parry, Elizabeth Phillips of the Henry Street Nursing Service who has been on the staff of the American Red Cross in England, and others.

The new publication of the National Tuberculosis Association on Personnel Problems of Sanatoria Resulting from War Conditions, for its systematic canvass of facts on personnel in a cross-section of American sanatoria. It is succinct and to the point and the mem-

bers of the Committee on Sanatorium Standards of the American Trudeau Society, of which Victor F. Cullen, M.D., is Chairman, are to be congratulated for producing this practical document.

An article entitled "Nutrition Exhibit, East Orange (New Jersey) Health Department, 1942," by Frank J. Osborne, Health Officer, for its careful inclusion of the sources of all display material and printed matter used in an ambitious five section exhibit. Reprints free on request to Mr. Osborne.

This week, and every week, "Health Articles of the Week, an Index to Current Periodical Literature on Public Health," compiled by the National Health Library, 1790 Broadway, New York, N. Y. Now in its 23rd year of publication, this weekly reference list averaging 4 mimeographed pages, directs attention to the important articles in all health and medical magazines under such headings as general, cancer, child welfare, communicable diseases, eyesight conservation, health education, health insurance, heart disease, industrial hygiene, mental hygiene, national defense and war, nursing, nutrition, tuberculosis, venereal diseases. Sample copy on request; subscription $2.50 per year.

PUBLIC HEALTH IN MICHIGAN MARKS ITS 70TH BIRTHDAY

The July issue of *Michigan Public Health*, published by the State Department of Health, is given over to a historical review of 70 years, since July 30, 1873, when the Michigan State Board of Health was created. The story includes many of the persons who have left the impress of their lives on Michigan during these years. Its effect is to build up public appreciation for public service rendered through health agencies.

"THE BEGINNINGS OF THE AMERICAN PUBLIC HEALTH ASSOCIATION"

Under the title "The National Quarantine and Sanitary Conventions of 1857 to 1860 and the Beginnings of the American Public Health Association," Harold M. Cavins, the Assistant Professor of Hygiene in the Eastern Illinois State Teachers College, Charleston, Ill., has published a paper in the *Bulletin of the Institute of the History of Medicine*, Vol. XIII, No. 4, April, 1943.

In view of the fact that the original sources of much of this information are difficult of access generally, the public health profession is in debt to Professor Cavins for putting this review on record. It is a very readable story.

BOOKS AND REPORTS

The Food You Eat—A Practical Guide to Home Nutrition—*By Samuel and Violette Glasstone. Norman: University of Oklahoma Press,* 1943. 277 pp. Price, $2.25.

The first few chapters of this book stress the physiology of nutrition, its relation to health, and the processes of digestion and energy metabolism. Next in order, mineral elements and water, then vitamins are discussed. A chapter on food products discusses the various groups of foods—cereal foods, dairy products, etc.—and the last chapter is devoted to "Planning the Menu." A section at the end of the book "Practical Nutrition in Outline," gives a brief summary of daily menu planning and of the requirements, functions, and sources of the various food components.

The title of this book leads one to think it is written for the homemaker, or at least for the lay reader. The use of words like creatinine, protein linkings, amino acids, and sterols do not add to the value of the book for lay persons. The use of these technical terms marks the book as a reference text for high school or young college students. As a matter of fact, the book is too technical and too wordy for easy popular reading. It is not a new approach to the subject of nutrition but a repetition in heavy detail. One is led to conclude, therefore, that the authors, one a physical chemist, the other a plant physiologist, were not conversant with nutrition in its relation to the problems of homemakers to discriminate as to what might be omitted and still have the story of nutrition effectively told.

For the most part the information is accurate. However, there are statements which might be questioned. The chapter devoted to menu planning often reverts to the authors' whims instead of being based on scientific facts. Because they eat little or no breakfast does not make the practice a sound one, neither is there a scientific reason for the omission of bread in certain meals, nor is there any reason why lunches should always contain sandwiches, nor that milk should be omitted from a meal when lemon meringue pie is eaten.

It is to be regretted that the authors chose to use the terms P.P. factor instead of niacin, vitamin B_1 and vitamin B_2 instead of thiamin and riboflavin, respectively.

MARIETTA EICHELBERGER

Miracles of Military Medicine—*By Albert Q. Maisel. New York: Duell, Sloan and Pearce,* 1943. 373 pp. Price, $2.75.

This book discusses very important matters and contains some reliable information, but it is a typical example of the danger of a layman writing on technical subjects. A few instances will suffice.

The author says that diphtheria antitoxin is more properly called "toxin-antitoxin" since it contains "not only the good antigens but also the bad diphtheria toxins." In regard to tetanus, he says that "until the first World War all cases were untreated." In 1897 Nocard sent tetanus antitoxin to 63 veterinarians, advising its use after operation. Among 2,727 animals so treated not one developed tetanus, while 259 untreated animals developed tetanus. Between 1898 and 1906 in France, 13,124 animals operated upon or wounded accidentally received antitoxin as a prophylactic, with not one case of tetanus (Vaillard). By 1905

the nonmedical officers of the French Army had been instructed to have all cases of wounds in army horses treated with tetanus antitoxin, yet according to the author, one would think that Ramon's work in 1926 in the French Army with his anatoxin was the first attempt to prevent tetanus in the cavalry, and he says "the rest of the world was just beginning to wake up to the import of his tetanus discovery." We give all credit to Ramon for his work, but alum precipitated toxoid, now almost entirely used, was described by Glenny *et al.* in 1926. It is true that the commercial manufacture making it generally available did not start until considerably later in this country.

In 1903 the *J.A.M.A.* began its campaign for the treatment of Fourth of July toy pistol and fireworks wounds. In 1914, among 1,506 such wounds, there were only 3 cases of tetanus and in 1916 there was not a single case.

These examples seem sufficient to put this book where it belongs. It will probably interest some readers and may do some good. The author is "conscious of the pitfalls that beset the lay writer who ventures a popular discussion of medical subjects," and gives an imposing list of men, mostly well known, who gave him information for his book. It seems to go without saying that the text was not submitted to anyone who knew anything about bacteriology. The book cannot be recommended as it will spread misinformation as to dates, credits, and facts.

MAZŸCK P. RAVENEL

Blood Groups and Transfusion—*By Alexander S. Wiener, M.D. (3rd ed.) Springfield, Ill.: Thomas,* 1943. 438 pp. Price, $7.50.

In Wiener's *Blood Groups and Transfusion,* a well bound and well printed volume, the author has added two new chapters in this third edition which is printed 38 months after the second in 1939. This volume summarizes as the author proposes: the present knowledge concerning the theory and technic of blood grouping; its application in clinical, legal and veterinary medicine and in anthropology, and assembles and integrates the essential facts concerning the transfusion of whole blood, plasma, and serum.

The volume is well illustrated with 69 figures, and many essential data are assembled in 106 tables. The handling of the accumulated literature is accomplished by references placed at the bottom of the page and by a General Bibliography at the back of the book. In this section also there is an appendix treating by statistical means the calculation of the genes A, B, and O if the distribution of the blood groups is known. The subject index is covered in 11 pages. There is no author's index.

In the new chapter on transfusion of stored blood, plasma, and serum, reference is made to Robertson's transfusions of stored blood in World War I. Due credit is given to work of Filatov and Bagdassarov in Russia and to the establishment of the first blood bank in this country at the Cook County Hospital by Fantus.

The question of survival of the transfused stored erythrocytes is well answered by the author's experiments using anti-M and anti-N agglutinating sera. These tests conclusively show that while fresh blood or blood only a few days old survives for periods up to 3 or 4 months, older blood disappears from the patient's circulation much sooner: i.e., blood stored for 21 days was found to survive only 24 hours. The author rightfully emphasizes the necessity of the collection of stored blood under a closed system, because the greatest problem in relation to plasma and serum transfusion is the prevention of contamination by bacteria and fungi. The safety of pooled plasma

is enhanced by pooling ten or more samples because the titer of the isoagglutinins is diminished by the factor of dilution and also to some extent through the neutralization of the isoagglutinins by group substance in solution. Various methods of drying plasma are presented with the correct admonition that plasma dried from the frozen state is to be preferred.

The second new chapter "Factors Rh and Anti-Rh of Human Blood" marks a lasting advancement not only because of the clinical importance of the Rh factor in reactions associated with repeated transfusions but also in the field of obstetrics in which the Rh factor is concerned with erythroblastosis foetalis, neonatal deaths, miscarriages, and congenital anemia of the new-born. Landsteiner and Wiener have shown that the Rh agglutinogen is a dominant gene. The chapter is purposely headed "Factors Rh." With the aid of standard anti-Rh sera, individuals are divided into only two types: Rh-positive and Rh-negative, the ratio being 85/15 among the white population. Wiener, however, shortly after the discovery of the first Rh agglutinogen, obtained from the serum of a patient who had a hemolytic reaction, an irregular agglutinin which acted on 70 per cent of bloods. A third type of human anti-Rh serum gives about 87 per cent positive reactions with the bloods of white individuals (Levine).

This knowledge will not only explain much of the pregnancy wastage due to mis-mating but will lessen intra-group hemolytic reactions, particularly those seen in certain pregnancy cases.

This book should become the standard text in medical schools and should be in the possession of all blood banks.

JOHN SCUDDER

Guide to the Inter-American Cultural Programs of Non-Government Agencies in the United States. *Compiled for the use of the Office of the Coordinator of Inter-American Affairs.* February, 1943. 181 pp.

The *Guide to the Inter-American Cultural Programs of Non-Government Agencies in the United States* is a worthy attempt at a comprehensive listing of nonofficial organizations in this country with Inter-American interests.

The format is somewhat sketchy, but the context should be valuable from a reference standpoint even though some omissions must be expected in an initial work of this nature. The descriptions of these agencies and institutions is entirely uncritical, but the outline of their activities and the names and addresses of their principal officers should be very useful to those individuals and officials who have to do business with the other republics.

EDWARD C. ERNST

Cases of Syphilis under Treatment in Cuyahoga County during March 1942—*By Howard W. Green. Foreword by Dr. James A. Doull.* 62 pp. Paper.

This report is the fifth in a series of consecutive annual statistical studies of patients treated for syphilis during the month of March, 1942, in Cleveland, Ohio. Since the schedules from which the information was compiled are identical with those used in 1938, 1939, 1940, and 1941, it is obvious that changes in the extent of syphilis under treatment, whether infectious or noninfectious, new or old, and treating agency can be easily ascertained. The study is presented mainly in the form of tables, charts, and graphs, with a minimum of text. An excellent summary recapitulates the findings of individual phases of the entire project, which provides factual data on the treatment status of syphilis in a large urban community. The observations recorded and problems encountered parallel those in similar areas.

The coöperation of the physicians of the community in answering the questionnaire (99.7 per cent replied) indicates a very helpful attitude on the part of the medical profession. Physicians treated more cases in 1942 than in the previous year; one wonders what effect the reduction of physicians in the civilian community, caused by the needs of the armed forces, will have on this finding next year, and whether the community facilities for the care of a larger load are adequate, particularly in view of the comment on page 57 "facilities for the treatment of syphilis in several of the hospital out-patient-departments are still being severely over-taxed by the enormous number of cases under treatment."

It is noted that the vast majority (83 per cent) of all cases of syphilis under treatment were non-infectious. It would be interesting to learn what percentage of these cases had already received the maximum benefit of therapy and for this reason should have been placed on "observation status" and no longer treated. In this connection the significance of Dr. Vonderlehr's recent statement becomes increasingly important "evidence shows that late and late latent syphilis now receives more attention in public clinics than is justifiable from a public health standpoint. It is essential that everything possible be done to provide adequate medical treatment for early patients and to discourage the attendance of the others, beyond the time when adequate treatment has been given. This idea should also guide the case holding." The problem of the patient with infectious or potentially infectious syphilis who lapses treatment before being rendered permanently non-communicable is emphasized.

The author and the Joint Social Hygiene Committee of the Cleveland Academy of Medicine and the Cleveland Health Council, which sponsored this study, are to be commended on an important contribution to the literature of syphilis control in this country.

THEODORE ROSENTHAL

Discovering Ourselves—A View of the Human Mind and How it Works—*By Edward A. Strecker, M.D., and Kenneth E. Appel, M.D. In collaboration with John W. Appel, M.D. (2nd ed.) New York: Macmillan*, 1943. 434 pp. Price, $3.00.

There can be little or no question concerning the need for more general dissemination of the methods of maintaining emotional health. Nor can there be question about the difficulty of communicating these methods to the public. In the second edition of the authors' popular presentation attempts are made to reduce the tabu of emotional and mental phenomena by recourse to simple definition and description of human emotions. These attempts are illustrated by clinical anecdotes and graphs. The additional chapters which concern emotion, anger and fear are of timely significance in the present world crisis with the need for adaptation to unrest and change.

In an appendix a series of questions are asked in an attempt to test one's understanding of the topics discussed. While it is quite possible, as the authors state, that one will experience a practical exercise in psychiatric therapy and promote one's own mental health, asking and answering questions may be far afield from the goal of effective emotional insight. One always has to consider the plight of the starving man who found a menu card of little value in appeasing his hunger.

The therapy that is favored throughout the book is that of greater self-knowledge concerning both the nature of mental conflict and the various means of dealing with it. The authors express confidence that such self-knowledge will do much toward attaining more

constructive methods of emotional adjustment. JOHN ROMANO

Building Morale—*By J. B. Nash. New York: Barnes,* 1942. 154 pp. Price, $1.00.

This book is unfortunately representative of a considerable number of publications and utterances upon morale. Written in an ecstatic, rambling style, it proceeds in a series of exhortations and emotional crescendo to its end without at any time bringing forward either valuable theory or practical planning concerning morale.

This phenomena of human behavior, morale, has attracted the liveliest attention from men of the most varied experience and attainment. Fascinated apparently with what has been accomplished by the Nazis through psychological warfare, representatives of the clergy, the army, journalism, women's clubs, and those interested in the cultivation of victory gardens have all hastened to express themselves. The results, as here, have been almost uniformly unfortunate. Morale is a part of human behavior and can only be dealt with informatively by those who have a background of training in the sciences which are concerned with that field. D. EWEN CAMERON

Social Hygiene Year Book—1942. The Program in Action in the States and Communities. *New York: American Social Hygiene Association,* 1943. 252 pp. Paper. Price, $1.00.

This paper bound volume collects, under one cover, a series of summaries of "current events and progress on the forty-eight fronts" which appeared in the *Journal of Social Hygiene* for April, May, and June, 1942. It aims to report the work of official and voluntary agencies since the last report, in 1938, and it is described, further, as "No. I in a new Journal series on Social Hygiene in Wartime."

State by state, in alphabetical order, it reviews the expansion of the programs of state and large city health departments and social hygiene societies, primarily as they are related to the war. It ranks each state according to population, indicates the number of A. S. H.A. members in each, provides a directory of state and national official and voluntary agencies concerned with social hygiene, and the names of their current executive officers.

The program material provides a fair indication of the current direction of the social hygiene program. Being a "progress report" it does not attempt to present the over-all social hygiene program of each state, although in some instances, this is woven into the progress report. Thus, the material is rather "spotty" in that it permits a view of some of the high points of the superstructure, but relatively little of the main edifice or its foundation.

There are four appendices, which outline the A. S. H. A. program, reproduce "important letters and documents," present and discuss certain "social hygiene laws and regulations," and display a collection of charts, tables and propaganda. N. A. NELSON

Public Health and Preventive Medicine—*By Morton C. Kahn, M.A., Ph.D., D.Sc. Oxford Medical Outline Series. New York: Oxford University Press,* 1942. 2 Vol. 534 pp. Price, $4.00.

An attempt to condense the entire field of public health into two pocket size 250 page books is a difficult feat. The author's solution has been to devote 390 pages to the Transmissible Diseases, but only 77 pages to Environmental Hygiene, and 48 pages to Public Health Administration. Obviously, the Transmissible Diseases overwhelm the rest of the Outlines. As an example, the 5 pages devoted to Anthrax and the 7 to Botulism outnumber the entire

presentation of Industrial Diseases. The latter discussion consists merely of 4 pages assigned to Silicosis, Asbestosis, and Lead Poisoning, and of 7 pages wherein are listed inorganic and organic chemical poisons with their industrial exposures. In the section devoted to the Environment, there is no presentation of illumination, no mention of food and restaurant inspection under Food Sanitation. Three full pages are devoted to Certified Milk, and 1 to the New York City milk supply, without mention of the phosphatase test. Under *Water*, no allusion is made to softening nor to taste and odor control. Orthotolidine is mentioned under *Sewage* but not in *Water*. The discussion of nutrition is confined to listing the vitamins and outlining their sources, requirements, stability, effects of deficiency and therapeutic doses, and to listing the essential amino acids.

Public health workers and students desiring an outline of communicable diseases will find these Outlines useful. These various diseases are presented under the headings of Etiology, Symptomatology, Epidemiology, Transmission and Prevention, with appropriate subheads. There are few inaccuracies in these sections. However, some appear. On page 404 yellow fever vaccine is rightly claimed to be produced from chick embryo, while on page 346 it is said to be grown on the chorio-allantoic membrane. One would hardly concur with the suggestion (page 464) of waiting for a Widal test to eliminate typhoid fever in the differential diagnosis of trichinosis. In the section on typhoid fever the importance of blood cultures in early diagnosis is properly stressed, although the technic (page 222) is poorly described: "During the first 10 days take several specimens of blood and plant in nutrient agar." Furthermore, one does not obtain fecal specimens from the duodenum.

The section of Environmental Sanitation has gross inaccuracies. Mussel poisoning (page 14) "may be a sex toxin due to spawning" (no mention of Gonyaulax). "All ground which cows traverse should by proper drainage be kept free from mud, puddles and manure" (page 29) is a statement which could have been eliminated with benefit. In Refuse Disposal the method used with success from New York to San Francisco, Fill and Cover, is not defined specifically. Its closest approximation is "mixing organic refuse with ashes." The description of an Imhoff tank is as follows (page 49): "A large cylinder has an upper chamber connected to a lower chamber by a funnel with a slit in the bottom . . . Gases thoroughly mix the old and new sewage in the upper chamber." The description of the activated sludge process would make it a discontinuous instead of continuous process.

Public Health Administration is also weak. Allocation of space is without much discrimination. Ten pages are given to the United States Public Health Service with only 3 pages to State, 5 to County, and 6 to City Health Departments. Actually, state and local venereal disease control is outlined under the United States Public Health Service. The Outline is inaccurate in listing as separate categories in Personnel of the State Department of Health both a Commissioner of Health and a State Health Officer.

Unqualified, sweeping statements consequent to outline form are particularly objectionable in this section on Administration. It is declared unwise to have a commissioner appointed by a governor, although, properly safeguarded, many would disagree with this opinion, and no alternatives are mentioned. On the other hand, the State Health Officer "selects and discharges subordinates" (page 482) (without regard to Merit System?). "School children should be tuberculin tested and

x-rayed" (page 470) (including grammar school children?). "Medical examination and treatment must be provided for workers" (page 472) probably alludes to industry, but is so presented that apparently it refers to the Municipal Health Department. On page 477, laboratories are dogmatically forbidden to County Health Departments while "at least ¼ of the budget" of County Health Departments "should be permanently subsidized by the State" (even in large, wealthy counties?).

The Outlines are well printed and have an excellent index. Blank pages are interspaced every 5 to 8 pages for notes. However, aside from the sections on Transmissible Diseases, the books will have a very restricted usefulness. CHARLES E. SMITH

Transactions of the Ninth Institute on Public Health Education—*New York: American Public Health Association*, 1943. 56 pp. Price, $1.00.

This volume is a valuable contribution to material on health education. We were asked the other day where and how one would find the best examples of health education in this country that might be visited and studied, or that might be reviewed by correspondence. We expressed the opinion that when this volume appeared it would constitute such a source of information and guidance, and we believe that it does.

In this report of the proceedings of the Health Education Section in St. Louis, one will find the products of up-to-date conference methods — informal group discussions with well selected panel leaders, assembling and interpreting information regarding community activities as laboratory material, all based on a recognition that maximum results necessitate a community plan, though not a universal standard pattern.

The "large urban area" is approached from many angles, including the participation of the schools in teaching health behavior and the rôle of the public health nurse as an educational influence in the home. The "smaller urban area" discussion brings out interesting references to the "Bridgeport Plan"; to the development in a populous community of volunteer workers, assisting the public health nursing personnel; to the organization, in certain southern areas, of district or block neighborhood groups (going back, perhaps unconsciously, to the Cincinnati Social Unit Experiment of 1916). Explored, also, are the activities and needs of the "urban-rural area" and the "rural area."

Dr. Philip S. Platt, fresh from the National Health Council study of voluntary health agencies, interprets public health effort as a phase in public relations. School and health department relationships are summarized by authorities in that field, such as Dr. Mayhew Derryberry, and Dr. George M. Wheatley, while exhibit technics are expertly interpreted by Homer N. Calver and Dr. Bruno Gebhard—from the angles of both war and peacetime needs.

This report reflects that throughout this session there was a keen awareness of the current political implications of public health work in general and of health education in particular. In this country we are choosing afresh the methods of democracy which, in public health as elsewhere, must depend on education. The Institute feels that our problem in this country is to create among individuals and communities "an understanding of and a desire to take part in the solution of their own health problems." Professor C.-E. A. Winslow in his keynote address, "Health Education in a Democracy," said: "The problem today is 'Can we on our side achieve coöperative action by common consent? Can we

do it in the war? Can we do it in the peace that follows?'"

Finally, there is also indicated an awareness that if we are to have sound health education, we must have soundly trained health educators. Standards and qualifications must be recognized and met—a point stressed by Dr. William P. Shepard in his address at this session, on "Educational Qualifications for Health Educators"—a report of the Committee on Professional Education of which Dr. Shepard is Chairman, and which has subsequently become available through the A.P.H.A. *Journal* and otherwise. As Dr. Shepard points out: "A great advance will be made when educators and public health authorities can agree on the functions, responsibilities, values, and training of those professional people who wish to devote themselves to the field of health education."

Of course, we would expect such an Institute to be good under the direction of a committee and faculty that contains such additional names from the public health roster as Dr. Horning (director), Dr. Bauer, Dr. Coffey, Miss Connolly, Dr. Halverson, Dr. Hiscock, Miss Jean, Dr. Nyswander, Mrs. Routzahn, Dr. Turner, Dr. Wilson, Dr. Amyot, Dr. Clarke, Dr. Douglas, Dr. Gudakunst, and Mr. Marquette—to name only a few. The report also contains an excellent bibliography of 46 pertinent references.

DONALD B. ARMSTRONG

BOOKS RECEIVED

MUNICIPAL AND RURAL SANITATION. Victor M. Ehlers and Ernest W. Steel. 3d Ed. New York: McGraw-Hill, 1943. 449 pp. Price, $4.00.

THE SCIENCE OF NUTRITION. By Henry C. Sherman. New York: Columbia, 1943. 253 pp. Price, $2.75.

KAISER WAKES THE DOCTORS. By Paul de Kruif. New York: Harcourt, Brace, 1943. 158 pp. Price, $2.00.

UNBIDDEN HOUSE GUESTS. By Hugo Hartnack. Tacoma, Wash.: Hartnack, 1943. Vol. I. Price, $12.00.

A SURVEY OF ALCOHOL EDUCATION IN ELEMENTARY AND HIGH SCHOOLS IN THE UNITED STATES. By Anne Roe. New Haven: Quarterly Journal of Studies on Alcohol, 1943. 132 pp. Price, $1.00.

MATERNAL OVERPROTECTION. By David M. Levy. New York: Columbia, 1943. 417 pp. Price, $4.50.

CHRONIC PULMONARY DISEASE IN SOUTH WALES COALMINERS. II Environmental Studies. His Majesty's Stationery Office, 1943. 222 pp. Price, $3.00.

SEX IN MARRIAGE. By Ernest R. Groves and Gladys Hoagland Groves. 3rd Ed. New York: Emerson, 1943. 224 pp. Price, $2.00.

HUMAN GASTRIC FUNCTION. An Experimental Study of a Man and His Stomach. By Stewart Wolf and Harold G. Wolf. New York: Oxford, 1943. 195 pp. Price, $4.75.

ANOPHELES GAMBIAE IN BRAZIL—1930 TO 1940. By Fred L. Soper and D. Bruce Wilson. New York: Rockefeller Foundation, 1943. 262 pp.

1941–1942 REPORT OF THE NEW YORK STATE COMMISSION TO FORMULATE A LONG RANGE HEALTH PROGRAM. Health Preparedness Commission. Albany: Williams Press, 1943. 413 pp.

A SELECTED PUBLIC HEALTH BIBLIOGRAPHY WITH ANNOTATIONS

RAYMOND S. PATTERSON, PH.D.

Health Insurance for Canada—Whole hearted endorsement of a really inclusive health insurance plan for Canada is given in two "submissions" by the Canadian Medical Association and the Canadian Public Health Association. The program is described in detail in an accompanying paper.

ANON. The Canadian Medical Association and Health Insurance (and) The Importance of Preventive Medicine and Public Health in National Health Insurance. Canad. Pub. Health J. 34, 7:299 (July), 1943.

"There Is a Harmony in Autumn"—In summer when the birth rate is highest, forces that tend to produce non-viable offspring are least active. Summer is the season when the best babies are born and (which is not the same thing) the best time for babies to be born, for infants that arrive during late spring and summer have a better chance to escape respiratory infections.

ANON. Summer Babies Are Best. Stat. Bull. (Met. Life Ins. Co.) 24, 6:3 (June), 1943.

Diphtheria Up—Diphtheria death rates were higher last year. Will the change in trend continue? How much is due to wartime conditions? The answers are not included with the tabulations.

ANON. Diphtheria Mortality in Large Cities of the United States in 1942. J.A.M.A. 122, 16:1079 (Aug. 14), 1943.

Fifty Had No Typhoid Deaths—Great improvement in typhoid fever rates is reported in this annual compilation. Evidently war travel and wartime crowding have not yet complicated the typhoid problems of our large cities.

ANON. Typhoid in the Large Cities of the United States in 1942. J.A.M.A. 122, 17: 1181 (Aug. 21), 1943.

Chest X-ray Faults—Arguments against mass radiography as a tuberculosis case finding measure, even poor ones, should be read by the proponents of this useful scheme. These are important.

BRAILSFORD, J. F. Mass Miniature Photography of the Fluorescent Image: A Criticism. Pub. Health. 56, 10:117 (July), 1943.

If Children Need Not Have Caries—We do know, concludes this paper on an oral hygiene study conducted in Green Bay, Wis., that the dental caries experience is greatly lessened in those who have continuously used fluorine-containing water since birth. If we do know that, it would seem to be about time that we did something about it, would it not?

BULL, F. A. The Rôle of Fluorine in Dental Health. J. Am. Dental Assoc. 30, 15:1206 (Aug.), 1943.

TB and Hospitals—Routine x-rays in one hospital revealed that 4 per cent of the patients, who would not otherwise have been detected, had evidence of tuberculous infection. Public health implications are obvious.

CHILDRESS, W. G., *et al.* Tuberculosis Case Finding by General Hospitals. J.A.M.A. 122, 16:1063 (Aug. 14), 1943.

Will Socialized Medicine Be Extended?—In this corner, pro: in that

corner, con. Eleven desiderata are enumerated.

DAVISON, W. C. Should American Medicine Be Socialized? J.A.M.A. 122, 16:1067 (Aug. 14), 1943.

Saludos Amigos—Do you know about the "Cooperative Inter-American Public Health Service" and the inter-American battle for health? There are health stations on the Amazon, health projects in Ecuador, health centers in Paraguay, and across Central America. Here is an interesting story commended to all.

DREISBACH, A. Inter-American Health Program Goes Forward. Pub. Health Nurs. 35, 8:445 (Aug.), 1943.

In Place of Jails and Lock-ups—Mentally sick persons, who are not well-to-do, must in too many states lean upon the tender mercies of the poor officer or the sheriff. New York began the movement to put these unfortunates under the care of health officials. Eight other states have followed in this humanitarian trend, the latest Oregon. Details of the state procedures are recounted.

HAMILTON, S. W. The Health Officer's Place in the Management of Mental Illness. Pub. Health Rep. 58, 26:979 (June 25), 1943.

When Only the Toughest Survived—For sheer pleasure read this picture of public health sixty years ago, which centers about the neighborhood pump from which the Flexner boys, Simon and Abraham, and their seven brothers and sisters (and young Yandall Henderson) drank.

HENDERSON, Y. Recollections of a Street Corner Pump and the Progress of Sixty Years. Science. 96, 2532:26 (July 9), 1943.

Long Forward Step—Local postgraduate demonstration clinics and seminars to bring the essentials of mental health to practising physicians have been inaugurated promisingly as one of the major activities of a state division of mental hygiene.

HAUGEN, G. B. An Approach to the Mental Hygiene-Public Health Problems. Pub. Health Rep. 58, 32:1211 (Aug. 6), 1943.

Public Health on Land and Sea and Air—Some of the things the 1,800 full-time medical officers of the U.S. P.H.S. are doing at the ends, as well as the middle of, and above the earth are recounted by the one man who knows most about their various activities.

PARRAN, T. The United States Public Health Service and the War. J.A.M.A. 122, 16:1092 (Aug. 14), 1943.

It's about Scarlet Fever—Some quaint, isolated villages in Magda ("Red Head") Lupescu's Rumania—hamlets free from scarlet fever but in an area surrounding an endemic focus—were selected for a study of the population during preëpidemic, epidemic, and post-epidemic stages. The report upon this study covers seventy pages. Approaching senility, the need of a summer vacation, and a reprehensible incuriosity about the subject, all combine to unfit this annotator to do more than remind you that this wealth of epidemiologic enlightenment knocks at your door for attention.

SCHWENTKER, F. F., *et al.* The Epidemiology of Scarlet Fever. Am. J. Hyg. 38, 1:27 (July), 1943.

Healthy Soldiers—In no month has the venereal rate in this country even approached the lowest monthly rate of the last wartime period. In general it may be said that the health of the army here and overseas is satisfactory. Statistics are presented to convince Doubting Thomas.

SIMMONS, J. S. The Present State of the Army's Health. J.A.M.A. 122, 14:916 (July 31), 1943.

Who Talked First and Why—Here ye'are! Read all about it! The

ding-dong, the bow-wow, the pooh-pooh, the yum-yum, and the babble-babble theories of speech beginnings. It isn't public hygiene but it's entertaining.

THORNDIKE, E. L. The Origin of Language. Science. 98, 2531:1 (July 2), 1943.

Radiant Disinfection of Air—Exploring the hypothesis that the spread of communicable disease depends upon deficiencies of the atmosphere, the authors present evidence to show that a tenfold increase in winter ventilation (or its equivalent in ultraviolet irradiation) does prevent the spread of air-borne contagion.

WELLS, W. F., and WELLS, M. W. Dynamics of Air-Borne Infection. Am. J. Med. Sci. 206, 1:11 (July), 1943.

Professional People Are Also Citizens—As it tosses out a bold challenge to the sanitary engineers to look beyond their technology and to take part in finding political, legal, and fiscal answers to post-war problems, this sparkling address should be read and taken to heart by all the specialists in the broad field of public health.

WOLMAN, A. The Post-war Rôle of the Sanitary Engineer. Sewage Works J. 15, 3:445 (May), 1943.

Influencing Human Eating Habits—Food store sales of the protective foods were used as a measure of the effect of an educational project in nutrition carried on in one section of a city. Marked gains in sales of a greater number of the protective foods were reported in the experimental area than in the control region. The advantages and limitations of this measuring device are discussed.

YOUNG, A. A Method for the Evaluation of a Community Nutrition Program. J. Am. Dietet. A. 19, 6:420 (June), 1943.

ASSOCIATION NEWS

THREE-DAY WARTIME PUBLIC HEALTH CONFERENCE AND

SEVENTY-SECOND ANNUAL BUSINESS MEETING

AMERICAN PUBLIC HEALTH ASSOCIATION

New York, N. Y., October 12, 13, 14, 1943

Headquarters: Hotel Pennsylvania

RATES QUOTED BY NEW YORK HOTELS

Wartime Public Health Conference and Seventy-second Annual Business Meeting—October 12–14, 1943

	Rooms With Bath	
	Single	*Double*
Headquarters:		
Hotel Pennsylvania, 7th Avenue and 33rd Street	$3.85– 8.80	$5.50– 9.90
Hotels near Hotel Pennsylvania:		
Governor Clinton, 31st Street and 7th Avenue	3.30– 5.50	4.40– 7.70
McAlpin, Broadway and 34th Street	3.30– 6.60	4.95– 8.80
New Yorker, 34th Street and 8th Avenue	3.85– 8.80	5.50–11.00
Selected Hotels Outside Pennsylvania Zone:		
Ambassador, Park Avenue and 51st Street	5.00– 8.00	7.00–10.00
Astor, Broadway and 44th Street	3.00– 5.00	5.00– 8.00
Barbizon (Women), Lexington Avenue and 63rd Street	3.00– 3.50	4.50– 5.50
Biltmore, Madison Avenue and 43rd Street	5.50–12.00	7.50–14.00
Bristol, 129 West 48th Street	2.50– 4.00	3.50– 6.00
Commodore, Lexington Avenue and 42nd Street	3.50– 5.50	5.50– 8.80
Cornish Arms, 311 West 23rd Street	2.25– 2.50	3.50– 4.00
Fifth Avenue Hotel, 24 Fifth Avenue (9th Street)	3.75– 5.00	5.00– 7.00
George Washington, 23rd Street and Lexington Avenue	2.00– 4.00	3.50– 6.00
Lexington, 48th Street and Lexington Avenue	4.00– 6.00	5.50– 8.00
Lincoln, 8th Avenue and 44th Street	3.00– 5.00	4.00– 8.00
Midston House, 22 East 38th Street	3.00– 3.25	4.00– 4.50
New Weston, Madison Avenue and 50th Street	4.00– 6.00	6.00– 9.00
Paramount, 46th Street, West of Broadway	2.50– 4.50	4.00– 8.00
Park Central, 7th Avenue and 55th Street	4.00– 5.00	6.00– 7.00
Parkside, 18 Gramercy Park South	2.50– 3.00	5.00
Piccadilly, 227 West 45th Street	2.50– 4.00	3.50– 6.00
Prince George, 14 East 28th Street	2.50– 4.00	3.50– 7.00
Roosevelt, Madison Avenue and 45th Street	4.50– 8.00	6.50–12.00
St. Regis, Fifth Avenue and 55th Street	6.00– 7.00	7.00–11.00
Seymour, 50 West 45th Street	4.00– 5.00	5.50– 6.00
Shelton, 49th Street and Lexington Avenue	3.50– 5.00	5.00– 7.00
Waldorf-Astoria, 50th Street and Park Avenue	7.00–10.00	10.00–15.00
Wellington, 7th Avenue and 55th Street	2.50– 4.00	3.50– 6.00

MEETING OF THE COMMITTEE ON PROFESSIONAL EDUCATION

The Professional Education Committee of the Association held a meeting in New York City on June 11 under the Chairmanship of William P. Shepard, M.D., of San Francisco. Important action of this session included a resolution concerning the emergency shortage of public health personnel. The committee invited Dr. Joseph W. Mountin, Assistant Surgeon General of the U. S. Public Health Service, Washington, for counsel regarding the acute shortage of personnel in all branches. Dr. Mountin pointed out that in many states federal grants-in-aid remain unexpended because the local health departments are unable to fill positions. The Service had advocated filling at least some of these positions with auxiliary personnel, but response to this method had so far not been encouraging. He expressed the opinion that there was no justification for allowing the level of health work to fall on the theory that we must maintain preconceived notions with respect to the qualifications of personnel. The seriousness of the situation was illustrated by several members of the committee who cited instances where sanitary sewage was seen running in open ditches through heavily populated streets, areas where there is a great lack of maternity care, and frequent attacks of gastroenteritis among travelers because of the overburdened food handling facilities. It was further pointed out that supervision of water and sewage treatment plants and of milk pasteurizing facilities have been notably weakened by the withdrawal of those trained and experienced in this work.

In responding to Dr. Mountin's request for the committee's aid in the solution of this problem, the committee asked that this subject be considered in the program of the Annual Meeting and the Committee on Professional Education formulated a memorandum for publication in the *Journal* and general circularization, indicating its awareness of this problem and advocating certain steps to be taken in its solution (see page 920 of the July, 1943, *American Journal of Public Health*).

The Committee on Professional Education received a report from its subcommittee on Merit Systems indicating that definite progress had been made and that the committee was now prepared to offer and was offering examinations for all classes of public health nurses and for most classes of medical health officers. The preparation of material for examinations of laboratory personnel was shortly to be undertaken.

The committee received and approved for publication a report on the Educational qualifications of Public Health Laboratory Workers (see page 882 in the July, 1943, *American Journal of Public Health*).

Similarly, a report on the Educational Qualifications of Health Educators was approved for publication (see page 998 in the August, 1943, *American Journal of Public Health*).

The committee considered further a report on Educational Qualifications of Medical Administrators which will include workers in maternal and child health, in tuberculosis control, in venereal disease control, in cancer control, and in mental and industrial hygiene.

A report was received from a new subcommittee under the Chairmanship of George J. Nelbach, New York, N. Y., on the Educational Qualifications of Executive Secretaries of Voluntary Health Agencies. The report, in the form of a first draft, was received and ordered circulated.

Further consideration was given to a report on the Educational Qualifications of Public Health Dentists, and

consideration was given to revision of the existing report on the Educational Qualifications of Health Officers.

A summary was presented of a preliminary report on the Educational Qualifications of School Physicians which has been prepared under the Chairmanship of C. C. Wilson, M.D., of New York, N. Y.

Progress reports were received by the committee on the Educational Qualifications of Professional Personnel in Sanitation, on the Qualifications of Public Health Nurses, of Public Helath Nutritionists, and of Public Health Statisticians.

On the recommendation of Henry F. Vaughan, Dr.P.H., Referee, it was voted to defer action on the preparation of a report on crippled children's specialists for the present.

The Committee on Professional Education considered a request from the American Association of Colleges of Pharmacy that the A.P.H.A. define the position of pharmacy among the public health professions.

Further consideration was given to a resolution regarding levels of compensation commensurate with professional qualifications.

The Committee on Professional Education considered a possible survey of the field of graduate education in public health and voted to continue the present liaison with the Council on Medical Education and Hospitals of the American Medical Association. It was the opinion of the committee that steps should be taken immediately to secure a greater uniformity in graduate degrees in public health. Attention was called to the fact that during the academic year 1941–1942, 27 different public health degrees were granted. Inquiry was made of the Association of Schools of Public Health as to steps that were being taken to correct this situation. The committee also considered the possible certification of schools of public health.

ISABEL B. LANDY
Associate Secretary

APPLICANTS FOR MEMBERSHIP

The following individuals have applied for membership in the Association. They have requested affiliation with the sections indicated.

Health Officers Section

Vernon F. Anderson, M.D., D.P.H., Government Medical Service, Belize, British Honduras, Senior Medical Officer

Francis H. Cole, M.D., Memphis and Shelby County Health Dept., Oakville, Tenn., Director, Div. of Tuberculosis Control

C. J. Fisher, M.D., M.P.H., City Hall Bldg., Tuscaloosa, Ala., Tuscaloosa County Health Officer

Frank F. Furstenberg, M.D., Bay Area Health Center, Valpariso, Fla., P.A. Surgeon (R), U. S. Public Health Service and Physician, State Health Dept.

Dr. G. Harold K. Gentle, M.P.H., St. Georges, Grenada, British West Indies, Medical Officer in charge of Health Centers

Gunnar Gundersen, M.D., 1836 South Avenue, LaCrosse, Wis., Member, State Board of Health

Clarence E. Houston, City Bldg., Washington, Pa., City Health Officer

Benjamin Ron Monroy, Av. Mexico No. 328, Tepic, Nay, Mexico, State Health Commissioner, Federal Dept. of Health

James P. Moon, M.D., 44 Vine St., Winchester, Tenn., Director, Franklin and Coffee County Health Dept.

Fritz Plotke, M.D., M.P.H., State Hospital, Chicago, Ill., Public Health Adviser, State Dept. of Public Welfare

Joseph J. Saia M.D., Hoopa General Hospital, Hoopa, Calif., Physician, Senior Grade, U. S. Indian Service

Alice M. Waterhouse, M.D., 3557 86th St., Jackson Heights, L. I., N. Y., Junior Health Officer, New York City Dept. of Health

Laboratory Section

William F. Bloom, 224 81st St., Brooklyn, N. Y., Jr. Bacteriologist, Sea View Hospital

Helen B. Brumbaugh, M.S., 4609 Bayard St., c/o Mrs. Price, Apt. 4, Pittsburgh, Pa., Serological Technician, Pittsburgh Public Health Lab.

Margaret J. Carlson, 824 West Ionia, Lansing, Mich., Bacteriologist, State Dept. of Health Labs.

Ivory L. Clinton, State Dept. of Health Lab., Lansing, Mich., Bacteriologist

Adrien S. DuBois, Richards Chemical Works, 190 Warren St., Jersey City, N. J.

Louis C. Felger, City Health Labs., San Antonio, Tex., Laboratory Director

Kathleen L. Gay, P. O. Box 727, Selma, Ala., Assoc. Bacteriologist, State Dept. of Health Laboratories

Lieut. Irving J. Greenblatt, Sn.C., Camp Stoneman Hospital, Calif., Asst. Chief, Laboratory Service, Army of U. S.

Laura M. Huntley, 312 W. Grand River, East Lansing, Mich., Bacteriologist, State Dept. of Health

Mildred Jefferies, State Dept. of Public Health, Montgomery, Ala., Assoc. Bacteriologist, Bureau of Labs.

Arden H. Killinger, Ph.D., Parke, Davis & Co., Detroit, Mich., Sr. Research Virologist, Research and Biological Labs.

Lieut. Peter J. Knaus, Sn.C., 4322 5th Ave., So., Minneapolis, Minn., Sanitary Officer, 279th Station Hospital, Camp Bowie, Tex.

Major Clarence F. Nave, Sn.C., Station Hospital, Fort Benning, Ga., Asst. Chief of Laboratory Service

Harry Pearse, M.S., State Sanatorium, Wallum Lake, R. I., Laboratory Director

Lieut. William S. Proudfit, Sn.C., 320 South 15th, Lincoln, Nebr., Sr. Bacteriologist, State Health Dept.

Hermann Sommer, Ph.D., Hooper Foundation, U. C. Medical Center, San Francisco, Calif., Asst. Professor of Medical Research

James L. Terrell, 4080 Detroit St., Beaumont, Tex., Director, Jefferson County Health Unit Laboratory

Mae L. Watts, M.S., 406 No. Ardmore Ave., Los Angeles, Calif., Bacteriologist, State Dept. of Public Health

Paul A. Wolf, Ph.D., 2010 Ashman St., Midland, Mich., Biochemist, Dow Chemical Co.

Vital Statistics Section

Mary C. Macdonald, 156 Allen Place, Hartford, Conn., Secty. of Tumor Record Registry, Cancer, Div., State Dept. of Health

Engineering Section

Leon S. Blankenship, 2736 E. Magnolia Ave., Knoxville, Tenn., Director, Div. of Sanitation, Knoxville-Knox County Health Dept.

Charles E. Cotton, Jr., District Health Unit, Twin Falls, Ida., Milk Sanitarian, State Dept. of Public Health

Vernon P. Crockett, 603 BMA Bldg., Kansas City, 8, Mo., Asst. Engineer (R), U. S. Public Health Service

Morton S. Hilbert, 818 John St., Apt. 1, Sault Ste. Marie, Mich., Sanitary Engineer, Chippewa County Health Dept.

Ladislaus T. Jodaitis, 458 State Office Bldg., Madison, Wis., Asst. Engineer (R) U. S. Public Health Service, (Assigned to State Board of Health)

James A. King, Jr., 1613 Pineola Ave., Kingsport, Tenn., Actg. Jr. Sanitation Consultant, Sullivan County Health Dept.

Capt. Wilburn H. Kittrell, Sn.C., New Orleans Staging Area, New Orleans, La., Survey Unit, Army of the U. S.

William B. Schreeder, Box 58, LaFayette, Ga., Public Health Engineer, Walker County Health Dept.

Charles T. Starkey, State Board of Health, Houston, Miss., District Milk Sanitarian

Norman S. Stearns, 16 Fuller St., Brookline, Mass., Sr. Sanitary Engineering Aide, State Dept. of Public Health

Rulon S. Tueller, Bannock County Health Unit, Pocatello, Ida., Sanitarian

Leonard P. White, Basement, City Hall, Houston, Tex., Sanitary Engineer, Water Div., Utilities Dept.

Charles L. Wood, Box 175, Marlboro, Md., Sanitary Engineer, State Health Dept.

Industrial Hygiene Section

Bruno Allary, M.D., D.P.H., Roberval, P.Q., Quebec, Canada, Medical Officer of Health

Mary Grebas, R.N., 3501 Garrison Blvd., Baltimore, 15, Md., Industrial Nurse, Bendix Radio

William Brice Pinder, East Bay St., Nassau, Bahamas, Member, Board of Health

Food and Nutrition Section

Richmond K. Anderson, M.D., Calle Viena, 26, Mexico, D. F., Mexico, Staff Member, International Health Div., Rockefeller Foundation

W. Hazel Bean, M.S., Reg. Office, State Health Dept., Jackson, Tenn., Regional Nutrition Consultant

Lola T. Dudgeon, M.S., University of Arizona, Tucson, Ariz., Extension Nutritionist

Henry R. Kraybill, Ph.D., 59 East Van Buren, Chicago, Ill., Director, Dept. of Scientific Research, American Meat Inst.

Leslie J. Rosenberg, 4014 Kansas Ave., N.W.,

Washington, D. C., Food Inspector and Bacteriologist, D. of C. Health Dept.

Maternal and Child Health Section

Robert J. O'Neil, D.M.D., 1208 Faithful St., Victoria, B. C., Canada, Provincial Clinician, B. C. Dept. of Health

Ruth Tartakoff, M.S., Childrens Bureau, U. S. Dept. of Labor, Washington, D. C., Regional Medical Social Consultant

Mildred Van Cleve, M.D., 4509 Edgewood Place, Riverside, Calif., Pediatrician, State Dept. of Public Health

Public Health Education Section

George R. Bedinger, M.A., 2944 Macomb St., N.W., Washington, D. C., Chief, Health and Sanitation Section, Federal Public Housing Authority

Leon M. Childers, D.D.S., Manhattan Beach Coast Guard Sta., Brooklyn, N. Y., P.A. Dental Surgeon (R), U. S. Public Health Service

Mary L. Gladish, 262 Pulaski St., Lawrenceburg, Tenn., Student, Univ. of North Carolina, School of Public Health

Sister Marie B. Masterson, 8200 W. Outer Dr., Detroit, Mich., Sisters of Mercy, Hospital Division

Joseph J. Obst, D.D.S., 798 E. 34th St., Brooklyn, 10, N. Y., Dentist

Julius A. Olean, M.D., P. O. Box 553, Midland, Tex., Director, Midland-Ector-Howard County Health Unit

M. Virginia Parsons, R.N., P. O. Box 547, Savannah, Ga., Assoc. Health Education Consultant, U. S. Public Health Service

Ruth D. Rains, 1014 Monroe St., Charleston, Ill., Student of Public Health Education, Univ. of North Carolina

Lucretia A. Saunders, 520 E. 54th St., Indianapolis, Ind., Public Health Educator, State Board of Health

Gordon H. Sears, M.A., 9108 Burning Tree Rd., Bethesda, 14, Md., Medical Care Adviser, U. S. Public Health Service

Agnes H. Thomson, 128 Spadina Rd., Toronto, Ont., Canada, Medical Officer, Provincial Dept of Health

Lieut. Julius H. Winer, M.C., 480 Lexington Ave., New York, 17, N. Y. Chief of Urological and Laboratory Dept., Armed Forces Induction Station

William E. Woods, Driskill Hotel, Austin, Tex., Health Education Consultant, State Health Dept.

Public Health Nursing Section

Marie R. Audet, R.N., 120 Grande Allee, Quebec, P. Q., Canada, Social Service Worker, Div. of Venereal Diseases, Ministry of Health

Francis Frazier, R.N., 706 Huntington Ave., Boston, Mass., Student, Harvard School of Public Health

Edith Hettema, City Health Dept., Portsmouth, Va., Venereal Disease Control Nurse

Ida McRoberts R.N., M.A., 131 S. Barry St., Olean, N. Y., Supervising Nurse, Cattaraugus County Dept. of Health

Della M. Poe, 210 E. Kathleen, Sikeston, Mo., Senior Nurse, Southeast Missouri Health Service, Inc.

Esther Porter, 829 Hampton Ave., Toledo, Ohio, Asst. Director of Nurses, City Board of Health

Ethelwyn H. Saxild, R.N., City Hall, Richmond, Calif., Supervisor of Public Health Nursing, Richmond Health Dept.

Mildred Tuttle, M.S., 216 N. Mulberry, Marshall, Mich., Consultant in Nursing Education, W. K. Kellogg Foundation

Epidemiology Section

J. Franklin McVeigh, M.D., M.P.H., 204 Plymouth Ave., S., Rochester, N. Y., Asst. District Health Officer, State Health Dept.

Elsmere R. Rickard, M.D., M.P.H., State Dept. of Health, Univ. Campus, Minneapolis, Minn., Director, Influenza Laboratory

School Health Section

Lewis S. Harris, Sr. High School, Orchard St., Belmont, Mass., Director, Dept. of Health and Physical Education, Belmont Schools

Esther T. Melrose, R.N., 1005½ W. Mullen, Waterloo, Iowa, School Nurse, Waterloo Public Schools

Unaffiliated

William T. Clark, M.D., 317 Hayes Bldg., Janesville, Wis., Member, State Board of Health

Capt. Harold M. Deane, V.C., APO 862, Postmaster, New York, N. Y., Veterinary Corps, U. S. Army

Stephen E. Gavin, M.D., 104 S. Main St., Fond du Lac, Wis., Member, State Board of Health

Lillian D. Long, Ph.D., 40 W. 67th St., New York, N. Y., Psychometrician, Merit System Study, American Public Health Assn.

Albert E. Rector, M.D., 103 W. College Ave., Appleton, Wis., Member, State Board of Health

Hildegarde Wagner, 340 E. 52nd St., Apt. 3D, New York, 22, N. Y., Field Director, Local Health Preparedness Committees, New

York State Health Preparedness Commission

Harrison A. Walker, M.D., 735 Penn Ave., N.E., Atlanta, Ga., Senior Surgeon (R), U. S. Public Health Service and Regional Medical Officer, Office of Civilian Defense

DECEASED MEMBERS

John W. Alvord, Chicago, Ill., Elected Member 1899, Charter Fellow 1922, Engineering Section

A. T. McCormack, M.D., Louisville, Ky., Elected Member 1919, Charter Fellow 1923

Orville H. Brown, M.D., Arcadia, Calif., Elected Member 1937

Leo F. Hall, M.D., Helena, Mont., Elected Member 1920

WILLIAM J. RYAN, M.D., Pomona, N. Y., Elected Member 1934, Maternal and Child Health Section

LESLIE T. WEBSTER, M.D., New York, N. Y., Elected Member 1935, Elected Fellow 1940, Epidemiology Section

ROBERT S. WESTON, Boston, Mass., Elected Member 1896, Charter Fellow 1922, 40 year member, 1938, Engineering Section

CORRECTION

On page 893 of the *Journal* for July, there is an outline of Bristol's method of treating verminous heads. It is stated in the item that lethane is a derivative of arsenic preparations. This is an error. Lathane 384 Special, according to the manufacturers, Rohm & Haas Company, Philadelphia, Pa., is a synthetic organic chemical product widely used as an insecticidal agent in household and industrial sprays. It contains no arsenic nor is any arsenic compound used in the process of its manufacture.

Further references to the use of this method for controlling the head louse can be found in the *British Medical Journal*, April 11, 1942, volume 1, page 464, and in a memorandum on Control of Head Lice issued in 1943 by the British Ministry of Health, No. 230A.

JOURNALS URGENTLY NEEDED

It will be much appreciated if readers will send spare copies of the July, 1941, January, 1942, January, 1943, and March, 1943, issues of the *American Journal of Public Health* to the Stock Clerk, American Public Health Association, 1790 Broadway, New York 19, N. Y.

EMPLOYMENT SERVICE

The Association Employment Service seeks to bring to the attention of appointing officers the names of qualified public health personnel and to act as a clearinghouse on employment. This is a service of the Association conducted without expense to the employer or employee.

From the registry of persons available, selected announcements are published from time to time. Appointing officers may obtain lists of all registrants on request.

Address all correspondence to the Employment Service, American Public Health Association, 1790 Broadway, New York 19, N. Y.

POSITIONS AVAILABLE

CAREER OPPORTUNITIES IN PENNSYIVANIA

Charles B. Frasher, Merit System Supervisor, Pennsylvania State Department of Health, 207 Blackstone Building, Harrisburg, announces that appointments will soon be made in the following branches of the State Health Department of Pennsylvania: Health Conservation, Tuberculosis Control, Venereal Disease Control, Pneumonia Control, Industrial Hygiene, Narcotic Drug Control, Environmental Hygiene, Public Health Laboratories, Maternal and Child Health Services, Crippled Children's Services, School Medical Inspection, Dental, Nutrition, Milk Sanitation, Public Health Education, Sanitary Engineering, Vital Statistics, Public Health Nursing, Accounts, Biologicals and Supplies, Merit System, Tuberculosis Sanatoria. Open competitive examinations will be held and the resulting lists are expected to be in existence for 2 years or longer. Residence requirements are waived for professional positions.

THE MERIT SYSTEM COUNCIL OF WEST VIRGINIA ANNOUNCES EXAMINATIONS FOR THE FOLLOWING POSITIONS IN THE WEST VIRGINIA STATE HEALTH DEPARTMENT

Position	*Salary*
Public Health Nurse (Class A)	$1,680–$1,980
Public Health Nurse (Class B)	1,500– 1,860
Public Health Nurse Trainee	1,380– 1,500
Graduate Nurse	1,380– 1,620
Junior Engineer	2,160– 2,640
Chemist	1.620– 2,100
Sanitarian	1,500– 2.100
Sanitarian Trainee	1,200– 1,500
Junior Bacteriologist	1,920– 2,400
Junior Serologist	1,920– 2,400
Technical Laboratory Asistant	1,500– 2,100

Age limits and residence in West Virginia have been waived in consideration of applicants for these positions. Appointments may also be made at a salary above the minimum. Applications will be accepted continuously and examinations given whenever enough applications are filed to assure adequate competition. Persons interested should make application to the Merit System Council, 212 Atlas Building, Charleston, W. Va.

Announcement is made of the following examinations to be held by the State Personnel Board, Seattle, Wash., for positions in the State Department of Health and County Health Departments:

Position	*Salary Range* *Entrance*	*Maximum*
Bacteriologist B	$160	$190
Laboratory Helper D	120	140
Laboratory Assistant C	140	160
Laboratory Technician	140	170
District Public Health Officer V	380	440
Public Health Nurse B	160	190
Asst. Venereal Disease Investigator B	160	190
General Sanitarian A	190	220
Milk Sanitarian A	190	220
Chief of Public Health Education	280	320
Senior Milk Sanitarian	220	250
Obstetric Consultant VI	440	500
Pediatric Consultant VI	440	500
Senior Bacteriologist A	190	220

Council of Social Agencies in large Midwestern city is seeking person to fill position of assistant secretary in its health division. Responsibilities include coördinating, planning, and promoting of adequate community health services. Involves working with medical and health agencies and organizations and with committees. Beginning salary $3,000. Applications should indicate training and experience and references. **Box R**, Employment Service, A.P.H.A.

Wanted: Two physicians, immediate appointment, full-time venereal disease clinician, conduct several small clinics rotating schedule. Experience preferred.

Salary $3,600 plus actual expense not to exceed $1,200. Write State Health Department, Santa Fe, New Mexico.

Wanted: Laboratory technician, tuberculosis hospital. 130–150 beds. Salary $175 per month and full maintenance. Opportunity to do research. Nice surroundings, good living quarters. Write Dr. Paul D. Crimm, Boehne Hospital, Evansville, Ind.

Physician—public health pediatrics. To assist director of maternal and child health in large California County Health Department. Major duties, conducting of infant and preschool health conferences and school examinations. Beginning salary $350 and travel allowance. California license required. Training and experience in pediatrics or public health or both. Immediately available. Address William C. Buss, M.D., Kern County Health Department, Bakersfield, Calif.

Wanted: A physician trained in tuberculosis to assume administrative control of the Bureau of Tuberculosis in an eastern city of 200,000 population. Salary $3,900-$4.500 plus cost of living adjustment. Address **Box B,** Employment Service, A.P.H.A.

Sanitarian wanted: Preferably with Bachelor's degree or engineering degree, plus public health experience or training. Must have own car. Applicant with lower qualifications will be offered an opportunity to take a short, free indoctrination course. Salary $1,920 per year with travel allowance of $50 per month, if qualified. Apply Dist. Dept. of Health No. 6, Central Office, Newberry, Mich., Dr. Franklin.

Tuberculosis Association in large eastern city will accept applications for position on staff as statistical research secretary. Requirements: basic training in vital statistics, ability to plan and carry out statistical studies in the field of public health. One month's vacation. Five day week, with occasional work on Saturdays. Address **Box C,** Employment Service, A.P.H.A.

Wanted: Pediatrician to supervise medical care of children at cerebral palsy center being established by private institution in coöperation with Illinois Division of Services for Crippled Children. Salary commensurate with experience and training. For further information write Lawrence J. Linck. Director, Division of Services for Crippled Children, 1105 So. Sixth St.. Springfield. Ill.

Wanted: Competent, thoroughly trained bacteriologist, woman or draft exempt man to take complete charge of splendidly equipped small industrial laboratory. Connecticut location, country environment, pleasant surroundings, excellent working and living conditions. Must have Ph.D. training or equivalent. Apply **Box D,** Employment Service, A.P.H.A.

Merit System for Personnel Administration in Delaware will set examinations for 3 positions in the Delaware State Board of Health shortly. The positions open for examination, together with the beginning salaries, are: Deputy State (County) Health Officer ($3,800), Pediatrician ($3,600), and Medical Social Consultant ($2,400).

These examinations will be unassembled, but successful candidates will be expected to appear in Delaware for an oral interview which will be a weighted part of the examination. Appointments may be expected soon after the examinations are conducted.

Information and specifications as prepared for each position may be secured by communication with the Merit System Supervisor, P. O. Box 1911, Wilmington, Dela., and application for examination must be made on the official form.

The Department of Health, New Jersey, whose industrial health activities have expanded rapidly during the present war, has announced its need for two full-time industrial hygiene physicians for its Industrial Hygiene Service. As one of the leading states in the production of war materials, New Jersey offers unusual opportunities for gaining experience in occupational disease control besides giving the physician a chance to make a valuable contribution to the war effort. The principal duties of the selected physicians will be consultations in regard to the following: control of occupational diseases; industrial toxicological problems; evaluation of adequacy of plant medical services; promotion of measures which will reduce absenteeism from non-occupational causes; and conduct of industrial health education activities. Physicians interested in these positions should write to the Department of Health, Trenton, N. J.

The Milwaukee Health Department is interested in obtaining an instructor in hospital nursing to conduct a student educational program in its communicable disease hospital. Salary offered begins at $125 per month with maintenance, and increases of $5.00 per month each year until $135 has been reached. To this

basic salary there has been added a cost of living bonus of $30.64 per month, making the total beginning salary $155.64 plus maintenance. Apply to Dr. G. F. Burgardt, Deputy Commissioner of Health, Milwaukee, Wis.

Wanted: Woman bacteriologist for midwestern research organization. Industrial experience not necessary. Applicant should have had basic training in bacteriology. Apply **Box P,** Employment Service, A.P.H.A.

Wanted: Public health physicians in Texas. George W. Cox. M.D., State Health Officer, Austin, Tex.

Wanted: Public health statistician for large California County Health Department College degree with training in statistics. Salary $200. Position open. Address William C Buss, M.D., Kern County Health Department. Bakersfield, Calif.

FOR OTHER POSITIONS AVAILABLE WRITE EMPLOYMENT SERVICE, AMERICAN PUBLIC HEALTH ASSOCIATION, 1790 BROADWAY, NEW YORK 19, N. Y.

In view of the current active demand for trained and experienced persons in public health it is suggested that prospective employers communicate directly with the Employment Service, American Public Health Association, 1790 Broadway, New York 19, N. Y., for up-to-date lists of applicants.

POSITIONS WANTED

Physician,. M.D. Yale, with private practice industrial medicine. Age 39 and draft exempt. Seeks opportunity as public health physician. **A-505**

Woman physician, well prepared in pediatrics, M.S.P.H. DeLamar Institute, Columbia University. 1943, seeks employment in the field of maternal and child health. preferably administrative in pediatrics. Excellent references. **A-507**

Physician. M.D. University of Arkansas, M.P.H. Harvard, experienced as county health officer. Age 35. Will consider position as city or county health officer or director of a bureau. **A-506**

NEWS FROM THE FIELD

NEW APPOINTMENTS TO STAFF OF THE CHILDREN'S BUREAU

Alice Brackett has been appointed as assistant director of the nursing unit in the Division of Health Services of the Children's Bureau. Since October 1, 1939, she has been regional consultant nurse for the Children's Bureau in San Francisco.

Joy B. Stuart has succeeded Miss Brackett as regional consultant nurse in the San Francisco office. Miss Stuart was consultant nurse in maternal and child health in the State Department of Health in Utah for several years and recently organized the nursing services of the War Relocation Authority.

Lucile Perozzi, former director of public health nursing in the State of Oregon, has been appointed as regional consultant nurse for the Children's Bureau in the Midwest area.

Ruth Doran, former regional consultant nurse for the Children's Bureau in the Southern area, has been appointed as consultant nurse in maternal and child health and nurse midwifery.

Hattie Hemschemeyer, assistant director of Maternity Center Association, New York, N. Y., and lecturer in nursing education at Teachers College, has been appointed as part-time consultant to the Children's Bureau in special problems of maternity nursing and nurse midwifery.

NEW YORK CITY CERTIFIED MILK TO BE PASTEURIZED

The New York City Board of Health recently passed the following amendment to Section 156 of the city Sanitary Code restricting the sale of raw certified milk and of certified raw milk products to persons presenting a physician's prescription. The new regulation will become effective January 1, 1944.

"*Regulation 15. Sale of certified milk, skimmed milk or cream (raw) on physician's prescription only.* No certified milk, skimmed milk or cream, other than 'Certified Milk (Pasteurized),' 'Certified Skimmed Milk (Pasteurized),' or 'Certified Cream (Pasteurized),' shall be sold or distributed in the City of New York except in those cases where a physician's statement, prescribing unpasteurized (raw) certified milk, skimmed milk or cream, is filed by the purchaser with the milk dealer. The physician's statement shall bear the date of issuance, the name and address of the consumer and shall be valid for one year from the date of issuance. Such statement shall be kept on file by the milk dealer and shall be open at all times to inspection by a representative of the Department of Health."

Health News, New York State Dept. of Health, 20, 30 (July 26), 1943.

DR. BLACKERBY APPOINTED KENTUCKY STATE HEALTH COMMISSIONER

The Kentucky State Board of Health has announced the election of Philip Earle Blackerby, M.D., who has served for years as Assistant State Health Commissioner, to the position of Secretary and State Health Commissioner to succeed Arthur T. McCormack, M.D., who died on August 7. Dr. Blackerby is a graduate of the University of Louisville School of Medicine in 1904. He joined the American Public Health Association in 1933 and is associated with the Health Officers Section.

DR. HUTCHESON APPOINTED COMMISSIONER OF HEALTH IN TENNESSEE

R. H. Hutcheson, M.D., who has served for some years as Assistant Commissioner of Health in Tennessee, was recently appointed Commissioner of Health by Governor Prentice Cooper,

succeeding W. Carter Williams, M.D., who has been called to military duty and commissioned a Lieutenant Colonel in the Medical Corps of the U. S. Army.

Dr. Hutcheson is a graduate of the University of Tennessee, M.D., 1930, and received his C.P.H. from Johns Hopkins School of Hygiene and Public Health in 1934.

MARYLAND STATE COURT OF APPEALS SUPPORTS BALTIMORE CITY HOUSING ORDINANCE

The Maryland Court of Appeals recently handed down a decision approving the constitutionality of Baltimore's health ordinance relating to housing. The ordinance was passed in 1941, according to the *Baltimore Sun*, in response to a strong public sense of outrage against slum conditions in Baltimore, and was designed to strengthen the hand of the Health Department in enforcing minimum housing standards. A case under the law was appealed on the ground that the ordinance was unconstitutional and gave illegal power to the Health Commissioner.

In its decision the Court of Appeals declared that "The only purpose of the ordinance is to protect and preserve the health of the people of Baltimore," and that "the city has the power under its charter to preserve the health of the city and to prevent and remove nuisances. The exercise of charter powers by a city is not discretionary but is a duty."

Baltimore Health News for August publishes the decision in full.

ROYAL COLLEGE OF PHYSICIANS ELECTS MEDICAL OFFICERS OF HEALTH TO FELLOWSHIP

Announcement recently has been made that the Royal College of Physicians in London has elected to Fellowship Dr. James Macintosh of Glasgow, Dr. Robert Hughes Parry of Bristol, and Dr. John E. Gordon, Professor of Preventive Medicine and Public Health at Harvard University Medical School, Boston, Mass. This recognition of health workers with Fellowships is said to be extraordinary in the history of the Royal College.

PERSONNEL CHANGES IN THE TERRITORIAL BOARD OF HEALTH, HONOLULU

As of June 5, 1943, Dr. Marion F. Haralson of the staff of the U. S. Public Health Service, who had been Commissioner of Public Health, was transferred from Honolulu, and on June 25 Charles L. Wilbar, Jr., M.D., was appointed to succeed him. A recent session of the Territorial Legislature has changed the title of the position from Commissioner of Public Health to President of the Board of Health.

Dr. Wilbar was released from active duty as a Major in the Medical Corps of the U. S. Army to accept this position. Previous to entrance into the Army he was Director of the Bureau of Maternal and Child Health of the Territorial Board of Health.

During the interim Richard K. C. Lee, M.D., Deputy Commissioner of Public Health, was in temporary charge of the department. He now serves as executive officer under Dr. Wilbar.

SOUTHERN BRANCH, A.P.H.A.

The Southern Branch of the American Public Health Association will have no formal meeting in 1943, but will have a meeting of the officers of the Association and the Governing Council.

CORRECTION

In the report "Check Anthrax" in the July *Journal*, page 855, it was erroneously stated that "it is regrettable that the U. S. Public Health Service has ceased to make anthrax in this country reportable to them." The facts are that detailed case records are no longer required, but weekly numerical reports are still received from the

states. The impression of certain individuals, referred to on page 856, that anthrax was no longer a particular hazard, grew rather from the fact that Department of Agriculture regulations regarding the importation and treatment of animal by-products, designed to prevent the dissemination of anthrax, were discontinued in 1940.

COURTENAY DINWIDDIE DIES

Courtenay Dinwiddie, sociologist and general secretary of the National Child Labor Committee, died September 13 in New York of a heart attack at the age of 60. Formerly director of health programs under the American Child Health Association and under the Commonwealth Fund, Mr. Dinwiddie was also consultant on child hygiene for the New York City Department of Health and at one time a teacher of community organization at Johns Hopkins University. He has been a member of the A.P.H.A. since 1916 and a Fellow since 1922.

PERSONALS

Central States

ERWIN C. CARY, M.D., of Reedsville, Wisc., has been reappointed Health Officer for the Village of Reedsville and also for the towns of Rockland and Franklin. He was recently re-elected President of the Manitowoc County Health Officers' Association.

VIDA H. GORDON, M.D., M.P.H.,† Director of the Sanilac County (Mich.) Health Department since June, 1941, has been appointed Director of Crippled Children Activities in Arkansas, with headquarters in Little Rock. Dr. Gordon was recently elected President of the Sanilac County Medical Society.

WILLIAM T. GROVE, M.D., of Eureka, Kans., has been appointed Health Officer of Greenwood County, to succeed WALTER S. MOONLIGHT, M.D., of Eureka, resigned.

ALICE M. HEATH, C.P.H.,† formerly Health Education Consultant for the Wisconsin Anti-Tuberculosis Association, has accepted a position as Director of Health Education of the Peoria County Tuberculosis Association, Peoria, Ill.

SAMUEL N. MALLISON, M.D.,† of El Dorado, Kans., has resigned as Health Officer of Butler County, to become Superintendent of the Southern Illinois Health District with offices in Harrisburg, Ill.

Eastern States

MARY M. ATCHISON, M.D., M.P.H.,† of Concord, N. H., has been appointed Acting State Health Officer of the State Department of Health of New Hampshire, to act during the leave of ALFRED LEO FRECHETTE, M.D., M.P.H.,† State Health Officer.

AMELIA H. GRANT, R.N., who has been Director of the Bureau of Nursing in the New York City Department of Health since 1928, retired recently. Commissioner E. L. Stebbins stated that no successor has yet been named. Miss Grant has been associated with the Henry Street Visiting Nurse Service, with the Department of Nursing Education at Teachers College, Columbia University, with the Yale School of Nursing, New Haven, and the Bellevue-Yorkville Health Demonstration. Miss Grant has twice been President of the N.O.P.H.N.

ROSE KOSHETZ† (M.S. in public health, Yale, 1928) has enlisted in the U. S. Army and after completing officer training expects to receive a commission. She has enlisted for overseas service and expects to return to the Middle East where she spent four years working as a dietitian in a large hospital in Palestine.

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* Fellow A.P.H.A.
† Member A.P.H.A.

FREDERIC W. NORDSICK,* who for 5 years has been associated with the American Institute of Baking, New York, N. Y., has resigned to accept an appointment in the Department of Applied Research of Standard Brands, Inc., at the home office, New York City.

ANTHONY J. SPARTA, M.D., has been named Health Officer of Easton, Pa., succeeding the late REUBEN S. RAUB, M.D., who died May 28.

DONALD K. TRESSLER, PH.D.,* since 1933 Chief of Research and head of the Division of Chemistry, New York State Agricultural Experiment Station, Geneva, N. Y., has joined the staff of the General Electric Company. He will be concerned chiefly with research on refrigeration and the freezing preservation of foods, working in the laboratories at Bridgeport, Conn.

HELEN M. WALLACE, M.D., M.P.H., who completed the course at the Harvard School of Public Health in May, has been appointed Junior Health Officer in the New York City Department of Health.

Southern States

MARYLAND E. B. BYRNE, M.D., has been appointed Director of Maternal and Child Health of the Dade County Health Unit, Miami, Fla.

TURNER E. CATO, M.D.,† has been appointed Director of the Dade County Health Unit, Miami, Fla., following the recent resignation of THOMAS H. D. GRIFFITTS, M.D., D.P.H.†

ELIZABETH HARVEY, of Silver Springs, Md., has been appointed Health Secretary to the Council of Social Agencies of Washington, D. C. and vicinity, effective September 15.

GLEN J. HOPKINS,† formerly Assistant Public Health Engineer of the Missouri State Health Department, has been commissioned as Past Assistant Engineer of the U. S. Public Health Service Reserve, and has been assigned to the South Dakota State Health Department as Director of the Division of Public Health Engineering. Mr. Hopkins also served as Secretary of the Missouri Public Health Association, and his successor as Secretary of this A.P.H.A. affiliated society is J. WARREN SMITH, Assistant Public Health Engineer, State Health Department, Jefferson City, Mo.

GORDON E. MCCALLUM,† Sanitary Engineer, U. S. Public Health Service, who has been Acting Chief of the Sanitary Engineering Section of the Medical Division of the Office of Civilian Defense since January, 1943, has been designated Chief Sanitary Engineer in charge of the Section. Mr. McCallum was assigned to the Medical Division in 1941 as Regional Sanitary Engineer for the Third Civilian Defense Region (Maryland, Virginia, Pennsylvania, and the District of Columbia) and the States of Ohio and West Virginia, and later was made Assistant Chief Sanitary Engineer.

HARCOURT A. MORGAN, JR., M.D.,† of Lewisburg, Tenn., head of the Bedford County Health Unit, has been placed in charge of a seven county area including the six adjacent counties of Grundy, Franklin, Warren, Bedford, Marshall, Moore, and Coffee, with headquarters at Manchester, Tenn.

JOHN E. OFFNER, M.D., of Weston, W. Va., was recently appointed State Health Commissioner.

B. M. PRIMER, M.D., M.P.H.,* formerly Health Officer in the Amarillo, Tex., Department of Health, is now Lieutenant Colonel, M.C., U.S.A., and is Commanding Officer of the

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